State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Aquatic Resources
Honolulu, Hawaii 96813

August 11, 2006

Board of Land and
Natural Resources
Honolulu, Hawaii

REQUEST FOR AUTHORIZATION TO ISSUE ONE NORTHWESTERN HAWAIIAN ISLANDS (NWHI) RESEARCH, MONITORING AND EDUCATION PERMIT TO DR. RUSSELL BRAINARD OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), PACIFIC ISLANDS FISHERIES SCIENCE CENTER (PIFSC), FOR ACTIVITIES UNDER THE NWHI REEF ASSESSMENT AND MONITORING PROGRAM (RAMP), VALID FROM LATE AUGUST THROUGH LATE SEPTEMBER 2006

The Division of Aquatic Resources (DAR) hereby submits a request for your authorization to issue a NWHI Access Permit to Applicant Dr. Russell Brainard of NOAA, PIFSC, Coral Reef Ecosystem Division (CRED). The Research, Monitoring and Education Permit, as described below, will allow activities to occur in the NWHI State Marine Refuge (0-3 miles) waters surrounding the following areas:

- Necker Island (Mokumanamana),
- French Frigate Shoals,
- Laysan Island,
- Maro Reef,
- Gardner Pinnacles,
- Lisianski Island and Neva Shoal,
- Pearl and Hermes Atoll, and
- Kure Atoll State Wildlife Refuge.

The activities covered under this permit will occur from late August 2006 through late September 2006, from the support vessel NOAA Ship Hiʻialakai.

INTENDED ACTIVITIES:

Marine macroalgae are among the most poorly understood organisms in tropical reef ecosystems, yet without them coral reefs could not exist. Their importance to the ecosystem is staggering: algae form the base of the food chain, occupy much of the available benthic substrate, and help to oxygenate the water for animal life to thrive.

Worldwide concern over the degradation of coral reef ecosystems is prompting researchers to find ways to effectively monitor reef health over time. Because macroalgae are among the fastest growing organisms in tropical reef systems, they may serve as useful "early warning" indicators of environmental change.

Baseline quantitative data collected from photoquadrat (picture) analysis and sample collections will provide permanent historical records that will form the foundation for long-term monitoring efforts necessary for the conservation and management of reef resources. Such monitoring will allow natural fluctuations of species abundance to be monitored and compared to areas adversely affected by anthropogenic activities or climate changes. Additionally, baseline historical studies will give researchers understanding of possible future alien species introductions, and might be critical in our ability to ameliorate any environmental damage.

At this time, CRED is beginning studies to compile comprehensive algae species lists and determine relative algal abundance at these islands, and whether it changes over time. In order for baseline information of algal diversity and abundance to be determined, collections of specimens from the field are mandatory.

A number of permanent transects have been established at fixed sites during previous cruises, with the intention of providing georeferenced markers by which researchers can return to precise locations on subsequent cruises so as to re-survey the reef at known time intervals. Additional permanent transects will be established in 2006 or later, and any markers that have become dislodged since their installation will need to be replaced/repaired. Previously-established as well as newly-established permanent transects will be surveyed in 2006 or later.

Several complimentary, non-invasive underwater surveys will be conducted to enumerate the diverse components of diurnally active shallow water reef fish assemblages. No collection of fish will be undertaken. In addition, quantitative counts for specific target marine invertebrates will also be conducted along belt transects to determine the average percentage cover of certain sessile species.

In order to better understand and analyze the healthy versus diseased states of corals, a maximum of ten coral samples of 5 cm in size will be collected at each location representing each species and health state. The number of samples collected at each location will reflect the incidence of disease or bleaching. These numbers allow the researchers the flexibility to take advantage of chance encounters with diseased and/or bleached individuals of the targeted species at each site visited. But they also translate to a substantial overestimation of the actual number of corals that will be collected.

Dive operations will be performed to replace and/or service a number of moored instrument arrays that are used to collect sea surface temperatures, ocean currents and other parameters. See Application for a table of the arrays with mooring coordinates.

DAR staff has found that the proposed activities in general are consistent with and support the purposes of the Refuge, primarily to better understand and manage the resources within the State Marine Refuge.

REVIEW PROCESS:

The permit was received by the DAR on May 20, 2006. It was sent out for review and comment to the following scientific entities: DAR staff (5), Division of Forestry and Wildlife, Northwestern Hawaiian Islands Marine National Monument, United States Fish and Wildlife Service. Native Hawaiians from the Office of Hawaiian Affairs, and Kaho'olawe Island Reserve Commission were also consulted.

Several reviewers from our staff and outside have responded and raised the following issues in regard to this Application:

- In General: A complete collection table is necessary as to what species, or at least genera or families, the Applicant proposes to collect. Applicant should clearly state the types of organisms that would be subject to taking and killing. The collection methods and sample numbers should also be identified.

- Algae Collection: More information would be helpful as to what species likely to encounter and what species already collected on previous cruises. Will these collections be duplicative?

- Corals: Coral collection sample sizes should be re-tooled to take into account the collections already made in the NWHI on previous cruises. For example,

  - 61 *Montipora capitata* samples have been taken and archived by Gates and Toonen from 7 sites. Is this research duplicative? Other alternatives should be explored to collect samples elsewhere.
  - The sampling table does not include *Porites lobata*. Yet this species is listed as being collected in the algae protocols section. A number of samples of this species are archived at HIMB. Should it still be collected this time? If so, it should be in the species collection table.
  - Special concerns should be addressed with some species such as *Montipora incrassate* and *Montipora dilitata*, a species listed by NOAA and DAR as a Species of Concern with strict prohibition of taking or disturbance. These species should not be collected in any event.

- Invertebrates: The collection table only asks for trapezid crabs and corals, but the USFWS documentation talks about collecting sponges, mollusks, crustaceans, echinoderms, cnidaria, sea slugs, etc. What exactly is to be collected in terms of invertebrates?

- Equipment Intallation: How many permanent transects will be installed, and where? Is this a departure from historical procedures?

- BOTCAM: How many blocks of concrete will be left behind by BOTCAM? How will this affect bottomfish behavior? There is concern that dropping these cement anchors might cause significant damage to the seafloor. Consensus is that BOTCAM methods should be better researched and developed in a less sensitive environment than the NWHI. Perhaps testing in the main Hawaiian Islands could prove feasibility of the methodology.

DAR also received comments from the Northwest Hawaiian Islands Marine National Monument. The Monument supports the application with the exception of the monitoring of bottomfish population with the camera bait stations (BOTCAM). The Monument also recommends that the applicants should be provided with a briefing on the Native Hawaiian cultural significance of the area, and that discharge must be regulated in accordance with Monument prohibitions when transiting Monument waters. See Attachment 1 for details of the comments.

No other issues or concerns were raised from the Native Hawaiian reviewers.

APPLICANT RESPONSE:

As of August 2, 2006, DAR staff has received materials from Applicant in response to the questions and comments raised by the reviewers. Applicant also indicated that some of their key scientists were on a research field trip on the sea and could not be reached for properly addressing the issues, but they will be available at the Board meeting if necessary. Please see Attachment 2 for details of the response.

It should be noted that Applicant has specifically withdrawn the request for deploying the BOTCAM instruments. The Applicant has prepared a modified species collection table based on staff and agency inputs. No endolithic algal research will be conducted.

In summary the Applicant has agreed to modify the coral species collections and has attached a new table to this effect. The Applicant has agreed not to collect any non-coral invertebrates on this cruise. The Applicant has withdrawn their request for the deployment of the BOTCAM. The Applicant has provided a table summarizing the sites where the monitoring pins are or will be placed. The Applicant has agreed not to do any endolithic algal research on this cruise. Lastly, the Applicant has provided a list of sites where redeployment and/or repair of the moored instrument arrays.

Per staff requests, the Applicant has submitted the following four tables that are necessary for the review of the Application:

- Algal Genera Collected on Past Cruises,
- Monitoring Pin Locations and Planned Installation Sites,
- Revised Coral Species Collections, and
- Sties Where Moored Arrays to Be Repaired or Replaced.

These tables are attached herein with the Application.

In addition, Applicant states that no fish or invertebrates will be collected on this cruise. The invertebrate zoologist on board of the cruise will be enumerating organisms in the field, but will not be interacting with or collecting them.

ADDITIONAL AMENDMENTS OF APPLICATION:

On August 2, 2006, Applicant informed DAR staff and requested for the following amendments to their original application:

1. In addition the *Porites lobata*, the following coral species should also be added to the list given in the original permit: *Acropora valida*, *Pocillopora damicornis*, *Pocillopora ligulata*.

2. In the original permit the following coral species were spelled incorrectly in the list: *Acropora paniculata*, *Montipora incrassate*, *Montipora flabellate*.

3. The permit requests collection of *Porites lutea*. This is the current name for what was recently called *Porites evermanni*.

4. Applicant agrees with our staff biologist Dave Gulko that the following two species are too rare for collection, and should be removed from the permit: *Montipora incrassate*, *Montipora dilatata*.

STAFF OPINION:

DAR staff is of the opinion that Applicant has properly addressed the reviewers' concerns and could be allowed for their activities as specified in the Application (as amended) and as outlined below with the following special instructions and conditions:

1. Allow the entry of the NOAA Ship *Hi'ialakai* into State waters to support Applicant's modified collection tables and activities at the Necker Island (Mokumanamana), French Frigate Shoals, Laysan Island, Maro Reef, Gardner Pinnacles, Lisianski Island and Neva Shoal, Pearl and Hermes Atoll, and Kure Atoll State Wildlife Refuge.

2. Allow monitoring of fish assemblages and quantitative counts of target marine invertebrates.

3. Allow collection of species as listed in the modified collection tables submitted by the Applicant.

4. Allow the collection of new species of macro and micro algae which has not been previously recorded or collect from a given site.

5. Allow <u>only</u> the collection of diseased or bleached coral s at the maximum of 10 coral samples per site per infected species to systematically describe the gross and microscopic morphology of the diseases. Additional coral collection protocols are also listed below:

   a. No extractive or invasive sampling will be done on any intact coral colony measuring larger than 1 m x 1 m x 1 m. Specific efforts will be made to avoid damage to any large colonies of coral.

b. No coral species other than those listed on this permit will be collected or impacted by any activities conducted under this permit.
c. The permittee must notify DAR O'ahu within one day of any instance of major damage caused to coral or other marine resources as a result of collection or other research activities conducted under this permit.
d. This permit provides for collection of live coral through selective breakage of portions of a live colony (fragmentation) in such a manner as does not result in any additional harm to the remainder of the colony.

6. Allow the replacement and installation of new monitoring pins at permanent monitoring sites as listed in the Applicant's Table. All pin locations shall be recorded via GPS coordinates.

7. Allow dive operations to replace and/or service the moored instrument arrays.

RECOMMENDATION:

"That the Board authorize to issue, with stated conditions, a NWHI Research, Monitoring and Education Permit to Dr. Russell Brainard of the National Oceanic and Atmospheric Administration, for access and certain activities within the designated State waters of the NWHI."

Respectfully submitted,

DAN POLHEMUS
Administrator

APPROVED FOR SUBMITTAL

PETER T. YOUNG
Chairperson

APPENDIX 1

State of Hawai'i
DLNR
Northwestern Hawaiian Islands State Marine Refuge
Permit Application Form

For Office Use Only
Permit No:
Expiration date:
Date Appl. Received:
Appl. Fee received:
NWHI Permit Review Committee date:
Board Hearing date:
Post to web date:

Type of Permit

☒ I am applying for a **Research, Monitoring & Education** permit. (Complete and mail Application)
- ☐ This application is for a NEW project in the State Marine Refuge.
- ☒ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

☐ I am applying for a permit for a **Native Hawaiian** permit. (Complete and mail Application)

- ☐ This application is for a NEW project in the State Marine Refuge.
- ☐ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

☐ I am applying for a **Special Activity** permit. (Complete and mail Application)

- ☐ This application is for a NEW project in the State Marine Refuge.
- ☐ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

Briefly describe **Special permit** activity:

When will the NWHI activity take place?

☐ **Summer** (May-July of _____ (year)
Note: Permit request must be received before February 1st
Specific dates of expedition ______

☒ **Fall** (August-November) of _2006___ (year)
Note: Permit request must be received before May 1st
Specific dates of expedition _Aug 26 – Sep 29

☐ **Other**

NOTE: INCOMPLETE APPLICATIONS WILL NOT BE ACCEPTED

Please Send Permit Applications to:

NWHI State Marine Refuge Permit Coordinator
State of Hawai'i
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawai'i 96813

NWHI State Marine Refuge Permit Application
See Appendix 2 for Application Instructions

Section A – Applicant Information	
1. Project Leader (attach Project Leader's CV or resume) ☒ CV attached Brainard, Russell E. Name: Last, First, Middle Initial	Chief, Coral Reef Ecosystem Division (CRED) Title
2. Mailing Address (Street/PO Box, City, State, Zip) NOAA Pacific Islands Fisheries Science Center 1125B Ala Moana Blvd Honolulu, HI 96814	Telephone (808) 983-3737 Fax (808) 983-3730 Email Address rusty.brainard@noaa.gov
3. Affiliation (Institution/Agency/Organization) NOAA National Marine Fisheries Service Pacific Island Fisheries Science Center (PIFSC)	For graduate students, Major Professor 's Name & Telephone
4. Sub-Permittee/Assistant Names, Affiliations, and Contact Information ☒ CV or resume attached Project leads are Peter Vroom, Robert Schroeder, Jean Kenyon, Bernardo Vargas-Angel (all affiliated with CRED) and Scott Godwin (affiliated with Bishop Museum)	
5. Project Title NWHI Reef Assessment and Monitoring Program (RAMP)	
6. Applicant Signature	7. Date (mm/dd/yyyy)

Section B: Project Information

8. **(a) Project Location**

☒ NWHI State Marine Refuge (0-3 miles) waters surrounding:

- ☐ Nihoa Island
- ☒ Necker Island (Mokumanamana)
- ☒ French Frigate Shoals
- ☒ Laysan
- ☒ Maro
- ☒ Gardner Pinnacles
- ☒ Lisianski Island, Neva Shoal
- ☒ Pearl and Hermes Atoll
- ☒ Kure Atoll, State Wildlife Refuge
- ☐ Other NWHI location

Describe project location (include names, GPS coordinates, habitats, depths and attach maps, etc. as appropriate).

See attached sheets.

(b) check all actions to be authorized:

☒ Enter the NWHI Marine Refuge waters

☐ Take (harvest) ☒ Possess ☐ Transport (☐ Inter-island ☐ Out-of-state)

☐ Catch ☐ Kill ☐ Disturb ☒ Observe

☒ Anchor ☒ Land (go ashore) ☐ Archaeological research

☐ Interactions with Sea Turtles or Monk Seals ☐ Interactions with Seabirds

☐ Interactions with Live Coral, Ark Shells or Pearl Oysters

☐ Interactions with Jacks, Grouper or Sharks

☐ Conduct Native Hawaiian religious and/or cultural activities

☒ Other activities Upgrade, maintain and install oceanographic moorings and other instruments

(c) Collection of specimens – collecting activities (would apply to any activity):

- No collection of fish will be performed.
- Inventories and collections of marine algae will be made. The NWHI contain up to 800 species of native marine algae, and small samples of voucher specimens will be collected for taxonomic species identification from each monitoring site visited. Because algal species require microscopic investigation for taxonomic identification, it is essential to collect voucher specimens to determine if algal diversity is changing at a particular site over time. Taxonomic information for species in the NWHI can be found in Abbott 1999 and Abbott & Huisman 2004.
- Collection of invertebrates listed below will be performed under the direction of Loren Scott Godwin (Bishop Museum). No broad scale collections activities of invertebrates will be performed.
- A maximum of 10 coral samples (a statistically relevant number) representing each species and health state, will be collected at each island/reef system visited. In reality, the number of samples collected at each location will reflect the incidence of disease and/or bleaching, and our past experiences suggest that individuals representing the compromised health states are rarely encountered. Thus, the sampling strategy planned herein provides the researchers the flexibility to take advantage of chance encounters with diseased and/or bleached individuals of the target species at each site visited but that translates as a substantial overestimation of the actual number of corals that will be collected. In collaboration with scientists at Tetra Tech and HIMB, histopathological and molecular analysis will be conducted to characterize the pathologies as well as further investigation to identify genetic markers associated with each disease. Dr. Ruth Gates, Hawaii Institute of Marine Biology (RuthGates, PhD) is using molecular tools to identify symbiont diversity as potential indicators of coral disease/bleaching susceptibility.
- Sea water samples will be collected and analyzed for nutrients, chlorophyll, dissolved inorganic carbon and other constituents.

Organisms or objects (List of species, if applicable, add additional sheets if necessary):

Common Name	Scientific Name	No. & size of specimens	Collection Location(s):
Guard crab	*Trapezia sp.*	10, 15mm diameter	All islands visited
Giant table coral	*Acropora cytherea*	10, 5 cm	All islands visited
Fuzzy table coral	*Acropora panuculata*	10, 5 cm	All islands visited
Rice coral	*Montipora capitata*	10, 5 cm	All islands visited
Lobe coral	*Porites lutea*	10, 5 cm	All islands visited
Plate-and-pillar coral	*Porites rus*	10, 5 cm	All islands visited
Finger coral	*Porites compressa*	10, 5 cm	All islands visited
Antler coral	*Pocillopora eydouxi*	10, 5 cm	All islands visited

Cauliflower coral	*Pocillopora meandrina*	10, 5 cm	All islands visited
Branching rice coral	*Montipora incrassate*	10, 5 cm	All islands visited
Irregular rice coral	*Montipora dilatata*	10, 5 cm	All islands visited
Lumpy rice coral	*Montipora turgescens*	10, 5 cm	All islands visited
Blue rice coral	*Montipora fabellata*	10, 5 cm	All islands visited
Sandpaper rice coral	*Montipora patula*	10, 5 cm	All islands visited
Crustose coralline algae		10, 5 cm	All islands visited

(d) What will be done with the specimens after the project has ended?

- Marine algae specimens will eventually be deposited in either the NOAA-CRED herbarium or the Herbarium Pacfiicum at the Bishop Museum in Honolulu, Hawaii.
- Invertebrate specimens will be housed at the Bishop Museum.
- Coral specimens will be fixed in zinc formalin and 95% ethanol, for histological examination and well as molecular analyses, respectively. Any remaining portions of the original samples will be accessioned at the Bishop Museum.

(e) Will the organisms be kept alive after collection? ☐ yes ☒ no

- Specific site/location ______________________
- Is it an open or closed system? ☐ open ☐ closed
- Is there an outfall? ☐ yes ☐ no
- Will these organisms be housed with other organisms? If so, what are the other organisms?

(Please attach additional documentation as needed to complete the questions listed below)

9. Purpose/Need/Scope:

- State purpose of proposed activities:

To conduct biennial reef assessment and monitoring activities throughout most of the major islands in the NWHI.

Describe how your proposed activities will help provide information or resources to fulfill the State Marine Refuge purpose and to reach the Refuge goals and objectives.

The proposed activities are consistent with and support the purposes of the Refuge as directed by the Department, specifically §13-60 5.1 (4) "To support, promote, and coordinate appropriate scientific research and assessment, and long-term monitoring of the refuge resources, and the impacts or threats thereto from human and other activities, to help better understand, protect, manage, and conserve consistent with applicable law."

The NOAA RAMP program is designed to provide managers with data needed to assess and monitor the state of the coral reef ecosystem in the U.S.-affiliated Pacific islands, including the NWHI.

- Give reasons why this activity must take place in the NWHI and cannot take place in the Main Hawaiian Islands, or elsewhere.

These activities are intended to monitor the state of the coral reef ecosystems in the NWHI and can only occur at that location.

- Describe context of this activity, include history of the science for these questions and background.

RAMP cruises have been conducted on an annual basis in the NWHI since 2000.

- Explain the need for this activity and how it will help to enhance survival or recovery of refuge wildlife and habitats.

These activities provide a baseline of key environmental and biological parameters and monitor those parameters for change over time.

- Describe how your proposed project can help to better manage the State Marine Refuge.

Baseline assessments and periodic monitoring are required to provide managers with information about the state of the coral reef ecosystem within the State Marine Refuge.

10. Procedures (include equipment/materials)

See continuation sheet.

11. Funding sources (attach copies budget & funding sources).

This project is funded by NOAA's Coral Reef Conservation Program.

12. List all literature cited in this application as well as all other publications relevant to the proposed project.

See attached project descriptions or USFWS SUP applications.

13. What types of insurance do you have in place? (attach documentation)

NOAA Ship HI`IALAKAI is a U.S. Government-owned and –operated research vessel and is self-insured by the U.S. Government.

☐ Wreck Removal

☐ Pollution

14. What certifications/inspections do you have scheduled for your vessel? (attach documentation)

☒ Rat free ☐ tender vessel ☒ gear/equipment

☒ Hull inspection ☐ ballast water

The ship has been certified by the U.S. Dept of Health and Human Services as rat-free as of April 2006. Hull inspections are scheduled with HIMB invertebrate specialists prior to working in the NWHI to ensure no alien species are transported into the area. All vessel equipment is inspected by NOAA's Office of Marine and Aviation Operaions on a biennual basis. Such a fleet inspection is scheduled to occur during June 2006.

15. Other permits (list and attach documentation of all other required Federal or State permits).

The NOAA ship HI'IALAKAI holds DLNR Permit # DLNR.NWHI06S003.
NOAA's PIFSC has pending Special Use Permit applications before the U.S. Fish and Wildlife Service to support these activities. Copies of those permits are attached.

16. Project's relationship to other research projects within the NWHI State Marine Refuge, National Wildlife Refuge, NWHI Coral Reef Ecosystem Reserve, or elsewhere.

RAMP activities are developed in partnership with federal, state and local agencies, including DAR, USFWS and the NWHI CRER.

Section C: Logistics

17. Time Frame:

Project Start Date	Project Completion Date
August 26, 2006	September 29, 2006

Dates actively inside the State Marine Refuge.

French Frigate Shoals	26 Aug-2 Sep
Gardner Pinnacles	3 Sep
Maro Reef	4-6 Sep
Laysan Island	7 Sep
Pearl and Hermes Atoll	9-13 Sep
(Midway Atoll	14-17 Sep)
Kure Atoll	18-20 Sep
Lisianski Island	22-24 Sep
Mokumanamana	27 Sep

(Subject to change)

Personnel schedule in the State Marine Refuge (describe who will be where and when).

See above. Entire ships complement (attached) will be within the refuge on the specified dates.

18. Gear and Materials

☒ Dive equipment ☐ Radio Isotopes

☒ Collecting Equipment ☐ Chemicals (specify types)

19. Fixed installations and instrumentation.

☒ Transect markers ☐ Acoustic receivers

☒ Other (specify)

It is possible that additional permanent transect markers may be located to facilitate some coral population surveys. Existing oceanographic instrumentation will be recovered and refurbished replacements reinstalled to ensure that a continuous time series of oceanographic parameters are maintained. As required to support the program's goal of ecosystem monitoring, a limited number of additional subsurface instruments may be attached to the reef in a non destructive manner. See attached protocol for deployment and recovery of instrumentation.

20. Provide a time line for sample analysis, data analysis, write-up and publication of information.

A report of all activities carried out under the permit authority will be submitted to the DLNR within 60 days of the conclusion of the mission. The report will include the dates of all arrivals and departures from islands and atolls within the Refuge, names of all persons involved, and a description of the work performed. A more detailed monitoring report will be available 120 days after completion of the mission.

21. **Vessel Information**:

Vessel Name NOAA Ship HI'IALAKAI IMO Number 8835619

Vessel Owner US Department of Commerce, NOAA Flag U.S.A.

Captain's Name LCDR Karl Mangels Chief Scientist or Project Leader Peter Vroom

Vessel Type Oceanographic research Call sign WTEY

Length 68.3 m. Gross tonnage 1,914

Port of Embarkation Honolulu

Last port vessel will have been at prior to this embarkation Pago Pago, American Samoa (15 Mar 2006)

Total Ballast Water Capacity: Volume _487 m^3 Total number of tanks on ship ____10______

Total Fuel Capacity: _____228,642_gal_________ Total number of fuel tanks on ship ___15____

Other fuel/chemicals to be carried on board and amounts:

Gasoline: up to 700 gal
Lube Oil: up to 10,442 gal
Numerous other industrial and household chemicals used to operate the vessel

Number of tenders/skiffs aboard and specific type of motors:

Ship's own tenders - 1 each 10 m AMBAR Marine jet boat with Yanmar 370-hp, Diesel inboard engine
1 each 8 m AMBAR Marine jet boat with Yanmar 315-hp, Diesel inboard engine
2 each 17.5 ft Zodiac inflatable boats, each with one Honda 50-hp, 4-stroke, outboard gasoline engine
1 each 19 ft AMBAR Marine rescue boat with Honda 115-hp, 4-stroke, outboard gasoline engine

PIFSC-provided tenders – 1 each 19 ft SAFE boat with twin Honda 75-hp, 4-stroke, outboard gasoline engines
1 each 19 ft SAFE boat with twin Yamaha 60-hp, 4-stroke, outboard gasoline engines

Does the vessel have the capability to hold sewage and grey-water? Describe in detail.

The ship has a 4,000 U.S. gal Collection Holding Tank for sewage and grey water. In those waters where effluent may NOT be discharged, sewage and grey water are held in this tank until the ship is in waters where sewage and grey water may be discharged. The ship has a U.S. Coast Guard-approved Marine Sanitation Device (Omnipure model MSD 12 MC) which is used to treat sewage and grey water in those waters where effluent may be discharged.

Does the vessel have a night-time light protocol for use in the NWHI? Describe in detail (attach additional pages as necessary)

The ship's navigation lights are lit 24-hours/day. At night the vessel does not illuminate deck lights unless required for night-time operations, such as conducting CTD casts. When deck lights are required only those necessary for safe deck operations are lighted.

On what workboats (tenders) will personnel, gear and materials be transported within the State Marine Refuge?

The tenders listed above will be used to transport gear and materials within the Refuge.

How will personnel, gear and materials be transported between ship and shore?

Work ashore is not a routine operation. In locations where oceanographic instrumentation is located in areas where access from shore is required, the tenders as described above will be used to transport personnel, gear and materials.

If applicable, how will personnel be transported between islands within any one atoll?

Transporting personnel between islands within any one atoll is not a routine operation. If required, the workboats and tenders described above will be used.

U.S. FISH AND WILDLIFE SERVICE
Research/Management Study Proposal
Hawaiian Islands National Wildlife Refuge

1. **Name and Address of the Applicant:**

Rusty Brainard
Chief, Coral Reef Ecosystem Division
Pacific Islands Fisheries Science Center
1125-B Ala Moana Blvd
Honolulu, HI 96814

2. **PROJECT TITLE**: Maintenance and upgrade of oceanographic monitoring stations within the Hawaiian Islands National Wildlife Refuge.

3. BACKGROUND: As part of the National Coral Reef Monitoring Program set forth in the *National Action Plan to Conserve Coral Reefs*, the Coral Reef Ecosystems Division (CRED) program at the Pacific Islands Fisheries Science Center of NOAA Fisheries has installed moored instrument arrays that monitor sea surface temperature, ocean currents, and other parameters at remote coral reefs within US jurisdiction. From 2001 through 2005, CRED personnel deployed multiple oceanographic instrument arrays during reef assessment and monitoring cruises to the Northwestern Hawaiian Islands aboard the NOAA ships *Townsend Cromwell, Oscar Elton Sette, and Hi'ialakai.* Coral Reef Early Warning System (CREWS) buoys are moored in protected lagoonal waters at French Frigate Shoals, Maro Reef, Pearl and Hermes Atoll, and Kure Atoll. Additional moorings are deployed in less protected areas exposed to sea and swell, including five Sea Surface Temperature (SST) buoys at Necker Island, Laysan Island, Lisianski Island (Neva Shoals), Midway Atoll, and Kure Atoll. Ocean Data Platforms (ODP) are deployed at Necker Island and Midway Atoll. Wave and Tide Recorders (WTR) are deployed at Lisianski Island and Kure Atoll. Subsurface Temperature Recorders (STR) are deployed throughout the archipelago. Benthic settlement plates are attached to the anchors of the CREWS and ODP moorings. The distribution of CRED oceanographic instruments collecting important time-series data in the NWHI is listed in Table 1.

4. OBJECTIVES and 5. JUSTIFICATION:

In-situ instrumentation deployed at long-term observing system sites in the Main and Northwestern Hawaiian Islands, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Remote Island Areas, provide time-series datasets which are utilized by researchers, resource managers, and stakeholders for the near real-time monitoring, alerting, modeling, and reporting of physical environmental conditions which influence the condition of coral reef ecosystems.

The in situ observing system in the Pacific is a significant and integral part of the Coral Reef Ecosystems Integrated Observing System (CREIOS). Activities support environmental monitoring stations (surface buoys with telemetry and subsurface archival moorings), deployed at various remote atolls and islands in the Pacific, providing a high-resolution time series of SST, salinity, PAR, UV-B, air temperature, barometric pressure, and wind velocity. The surface telemetered observations are augmented by a cost effective network of subsurface instruments recording water temperature, salinity, current profiles, wave, and tide data. In addition, during Pacific RAMP cruises, closely-spaced shallow water CTDs and shipboard deepwater CTDs and ADCP current profiler transects are conducted to provide a more detailed spatial (horizontal and vertical) description of ocean conditions. Integration of the spatial and temporal data from surface and subsurface moorings and in situ observations provides researchers and resource managers an improved understanding of the influences of environmental processes on the health of the surrounding coral reef ecosystems.

Near real-time data telemetry serves to alert resource managers and researchers of environmental events significant to the health of the surrounding coral reef ecosystem, allowing managers to implement additional protective measures in a timely manner, if warranted. These in situ measurements ground-truth satellite observations used by the NOAA Coral Reef Watch (CRW) in issuing coral bleaching alerts and warnings. This information is used to improve the quality of CRW HotSpot, Degree Heating Week, and Trend Analyses. In situ sensors provide important ground-truth data used to maintain accuracy -- removing any biases, and compiling statistics with time -- of remotely sensed information products. The time series data provided by the monitoring stations represent an important component of the field observations and ecological assessments conducted every 1-2 years in the vicinity of the monitoring stations. In situ time series data and ecological assessments assist researchers and resource managers in distinguishing between natural and anthropogenic changes to the ecosystems.

CRED Mooring stations have been established and maintained in NWHI, Main Hawaiian Islands, Commonwealth of the Northern Marianas Islands, Guam, American Samoa, and the Pacific Remote Island Areas (PRIAs) since circa 2001.

Also see Special Use Permit #12521-03027 for additional information.

We are requesting a permit to conduct operations required to service and maintain an existing array of long-term monitoring stations located in the NWHI. These stations are part of the Pacific Coral Reef Ecosystems Integrated Observing System (CREIOS). The maintenance and servicing of these observing system assets is one of the objectives of the cruise. Based on field observations and conditions specific sensors may be removed and/or others sensors added in the same general vicinity.

6. PROCEDURE:

A. Permits: No permits other than a USFWS Special Use Permit are necessary.

B. Methods:

1. Study Sites: We would like to perform dive operations to replace and/or service the following instrumentation.

Location	Instrument					
	CREWS	SST	ODP	WTR	STR	
French Frigate Shoals	1				6	
Gardner Pinnacles					1	
Maro Reef	1				3	
Laysan Island		1			3	
Pearl and Hermes Atoll	1				6	
Midway Atoll		1	1		5	
Kure Atoll	1	1		2	3	
Lisianski Island		1		2	2	
Necker Island		1	1		1	
Note:						

Table 1: Oceanographic instruments to be serviced in the NWHI

2. Techniques:

a. CREWS Replacement: The Coral Reef Early Warning System (CREWS) buoy replacements will involve raising the ~1200 lb buoy anchor with a lift bag, and swapping out the old mooring system and buoy for new ones. The buoy anchor is replaced by deflating the lift bag and guiding the anchor to the original location on the bottom. Alternatively, the old anchor is removed and a new anchor is positioned in the original location. The old anchor is recovered and returned to Honolulu. See Appendix A: CRED Dive Protocol: CREWS Buoy.

b. ODP Replacement: Ocean Data Platform (ODP) replacements will involve the installation of a new instrument array and the removal of the old array. The cement anchor will be left in place and reused. The instrument arrays will be gently lowered and raised using lift bags. See Appendix B: CRED Dive Protocol: ODP.

c. SST Replacement: The Sea Surface Temperature (SST) buoy replacements involve removing the old anchor and SST buoy and replacing it with a new anchor and buoy. A lift bag will be used to slowly lower and raise the anchors and the new anchor will be set in the same spot as the old. The old anchor and buoy are recovered and returned to Honolulu. See Appendix C: Diagram of SST Mooring.

d. WTR Replacement: Wave and Tide (WTR) replacements involve completely replacing the instrument and integrated anchor weight. The old instrument and anchor weight are recovered and returned to Honolulu. See Appendix D: Photograph of SST Mooring.

e. STR Replacement: Sub-surface Temperature Recorder (STR) replacements involve completely replacing the instrument and integrated anchor weight. The old instrument and anchor weight are recovered and returned to Honolulu. See Appendix E: Photograph of STR Mooring.

f. Protocol for Minimizing Benthic Disturbance: CRED divers have experience deploying moorings using the techniques detailed above. In all cases, divers aim to return anchors to within inches of original sites and avoid undesired contact with the substrate minimizing disturbance to the ecosystem.

3. Maintenance and Longevity: The instrument arrays are conceived to be a long-term scientific feature. We plan to change out arrays every one or two years and maintain them when needed with the sites remaining consistent from year to year.

C. Interpretation: Obtaining a near-continuous stream of physical and biological oceanographic data from areas that have been previously known only from sporadic, ship-based observations will better enable scientists and resource managers to characterize the regime under which coral reef ecosystems function. These systems can also provide early warnings of features, such as increased sea surface temperature, which may have impacts on the health of the coral reef ecosystem. In order to insure the continued collection of these data periodic maintenance is required.

D. FWS staff and space needs: No assistance is required by USFWS staff.

E. Hazmats: No hazardous materials are required.

7. PERSONNEL

Principal Investigator: Russell Brainard, Ph.D., CRED Chief, PIFSC, NOAA Fisheries
Kyle Hogrefe, Coral Reef Ecosystem Research Specialist, CRED, UH-JIMAR
Jamison Gove, Oceanographer, CRED, UH-JIMAR
Ronald Hoeke, Oceanographer, CRED, UH-JIMAR
Daniel Merritt, Engineer, CRED, UH-JIMAR
Oliver Daemeron, Marine Ecosystems Specialist, CRED, UH-JIMAR
Kevin Lino, Marine Ecosystems Specialist, CRED, UH-JIMAR
Charles Young, Marine Ecosystems Specialist, CRED, UH-JIMAR
Or other qualified personnel TBA

8. COSTS: No costs will be incurred by U.S. Fish and Wildlife Service in order to conduct this work.

9. SCHEDULE: The cruise will depart August, 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

10. Transportation: All personnel will be transported to and from units of the Hawaiian Islands National Wildlife Refuge onboard the NOAA vessel *Hi'ialakai*.

11. REPORTS and 12. PUBLICATIONS: See Permit # 12521-02010 for reports on buoy data. A summary report of buoy replacements accomplished will be submitted to USFWS by August 2006.

Russell E. Brainerd Date: 17 May 2006
Submitted by:

______________________________ Date: __________
Wildlife Biologist (Concurrence)

______________________________ Date: __________
Refuge Manager (Approval/Concurrence)

The following, if required:

______________________________ Date: __________
Refuge Complex Manager (Approval/Concurrence)

______________________________ Date: __________
Project Leader (Approval/Concurrence)

______________________________ Date: __________
Regional Office (Approval/Concurrence)

Appendix A

CRED Dive Protocol: CREWS Buoy

(Revised 02/05/2005, K.Hogrefe)
The goal of this operation is to deploy a CREWS buoy (see Figure 1) at a new site or to replace a CREWS buoy at an established site.

Equipment and Personnel

EQUIPMENT
1-2 small boats (outfitted as required by NOAA Small Vessel Safety Program)
1 set of dive gear + 80 cf tank per diver
1 visual signaling device per diver (telescoping flag or safety sausage)
1 portable, waterproof oxygen kit

1 tool kit (w/ the following)
- 2 crescent wrenches
- 1 channel locks
- 1 stubby flathead screwdriver
- 1 pair of wirecutters (for clipping zipties)
- 1 pair of needlenose pliers
- 1 tube of aqua lube
- 1 roll of electrical tape
- 2 1 ¼" SAS shackles (1 extra)
- 3 ¾" SAS shackles (1 extra)
- 5 spare cotter pins of assorted sizes
- 4 carabineers (snap links)

1 2000 lb lift bag
2 80 cf air tank
1 SCUBA tank yoke w/ brass nipple fitting
1 6 inch oval brass ring with 4 steel shackles (to attach liftbag to clump anchor)

1 hogging line (rope to tie around buoy with loops for towing)
1 towing bridle
1-2 towing lines
2-3 taglines (~30 feet long)

1 GPS unit
1 data slate
- 1 navigation data sheet
- 1 dive data sheet
- 1 chartlette with navigational info

1 Digital camera in waterproof housing

1 Settlement plate array (PVC framework w/ embedded ceramic plates)
- 1 ~ 8 ft diameter plastic loop w/ hose-clamp and fitting
- 8-10 zipties (18" long, ¼" wide)

NOTE: New settlement plate arrays are usually only deployed on an annual or biannual basis during RAMP cruises. Otherwise divers will need to work around them during operations. They should be handled gently and re-affixed to the CREWS anchor.

PERSONNEL
3-4 working divers or scientific exemption divers with mooring STE
(One diver must act as safety diver, they may be a scientific exemption diver without the mooring STE.)
1 dive supervisor / coxswain (ie person in the boat)

NOTE: The dive supervisor and the coxswain may be, but do not have to be, the same person.

It works best to give assignments to the team by task, designating a lift bag operator, a hardware handler, a line handler / hardware assistant and a safety diver.

Lift bag operator is dedicated to controlling the lift bag and its load during all phases of the operation. They should not be distracted from this task until the anchor is on the bottom with the lift bag deflated and the tank removed.

Hardware handler stands by with gear ready while the load is moving to connect or disconnect hardware when the anchor is at the surface or on the bottom.

Line handler / hardware assistant helps control the load by manning tag lines during the ascent and descent while they help the hardware handler with tools and heavy gear when the load is at surface or bottom.

Safety diver assures that divers do not fall victim to the hazards associated with this type of operation. They should monitor the other divers at all time to watch for entanglement hazards, exposure to overhead weights, objects overhead on the surface during a liftbag ascent, frisky sharks or any other hazard that the team may encounter. Due to the need of the safety diver to be omni-aware, they should not participate in general operations. The exception to this rule is that they may photo-document the operation.

Deployment and Recovery

Deploying a CREWS buoy can be a relatively involved task and is anticipated to take from 60 to 90 minutes once the CREWS buoy and the anchor (on a liftbag) have been towed to the site.

Dive Preparation
The safety and efficiency with which the installation or replacement operation can be completed is dependant on team preparation once at the dive site. To set up for the dive, up to four tasks should be completed.

Anchor the skiff.
Anchor so that, once the scope is accounted for, the small vessel is positioned 10 – 15 feet upwind of the chosen site for the buoy. Taking the time to anchor with proper positioning and a secure set are essential for a safe and smooth operation.

Take a CTD measurement.
The conductivity sensor on the buoy can "drift" over time and result in inaccurate salinity data. The CTD measurement near then end of an old buoys deployment helps to rectify this problem.

- Tie the knotted end of the line to a rail or cleat and attach the shackle on the other end of the line to the padeye at the top of the CTD frame.
- Turn the CTD power switch from "OFF" to "ON".
- Hold the line and drop the CTD over the rail. Allow it to "soak" for 30 seconds or until bubbles stop coming out of the clear plastic tubing.
- Lower the CTD to the bottom at the rate of ~ 2 feet per second.
- Pull the CTD up, bring it on board and turn the switch from "ON" to "OFF".
- Refer to the CTD SOP for more information on CTD operation.

Photodocument the old CREWS assembly.
Take photographs of the old mooring set-up. Take multiple pictures of anything that is broken or appears to be irregular. Take one or two close-ups of the accumulator

connections to the anchor and buoy, the settlement plate array and the subsurface mast.
Take some photos at distance (as allowed by visibility) of the entire mooring system both above and below water.

Raise the subsurface mast of the old buoy. (2 people)

Note: For this task, it helps to have one person (relatively short and light) sitting/crouching on the float deck of the buoy and one in the water with mask, fins and snorkel.

- Raise the ss mast by passing from the person in the water to the person on the float.
- Remove the lower of the two bolts securing it to the body of buoy.
- Loosen the second bolt slightly.
- Raise the ss mast by passing from the person in the water to the person on the float deck. The buoy will list severely to the side, which serves as an advantage in raising the mast. Just hang on tightly to the main mast and avoid dropping the ss mast.
- Lash the masts securely together.
    - **Use several wraps of strong line to secure the mast.** Do not underestimate the weight of the subsurface mast once out of the water. Don't rely on a single zip tie or single wrap of line because it is a BAD situation if the mast breaks loose during transit or particularly when it is lifted from the water to the mothership.
    - There is a bolt hole welded to the main mast that will meet with one on the subsurface mast, but the "hole match up" of the second bolt must be changed for them to align properly. This is difficult in the water, but should be done aboard the mothership for more secure storage.

Remove the electrical tape and cotter pins from the SAS shackles.

The accumulator is connected to the buoy by either two 5/8" safety shackles or a 1 ¼" and a 5/8" safety shackle and to the anchor by two ¾" safety shackles. The shackles immediately connected to the buoy to the accumulator will be removed as part of the operation, so clear them of the electrical tape around the nuts and pull out the cotter pins, but **leave the nuts in place**. This will enable divers to quickly remove the shackles once the anchor is suspended. Leave the shackle immediately attached to the anchor intact as it will be used as a lifting point.

Prepare the new accumulator for deployment.

- Apply Aqua-lube to the threads of all shackles to be actively used by the divers during the deployment (one 1 ¼", one 5/8" and two ¾" shackles).
- Wrap electrical tape around the nuts and cotter pins of all accumulator shackles that won't be actively used in the deployment.
- Nestle the loops (the "U" shaped piece) of the 5/8" and 1 ¼" shackles and then run the bolt of the 5/8" shackle through either the top link of the chain or the free shackle on the buoy end of the accumulator. The loop of the 1 ¼" shackle will now be secure enough to not fall out.
- Pocket the bolt, nut and cotter pin of the 1 ¼" shackle. It will now be easy to attach the accumulator to the buoy once the anchor is suspended.

Stage the new accumulator and settlement plate array. (as applicable)

If the accumulator and/or the settlement plate array are being replaced, lower them to the bottom over either side of the stern depending on the skiff's position. Leave them tied off.

Remove the larval coral settlement plates and set them aside.

NOTE: This task can be accomplished as a free dive, a short SCUBA dive before the operation or the first step of one of the following procedures.

- Cut the zip ties that attach the center of the array to the anchor using a knife or wire cutters and loosen the hose clamp that holds the base loop of the array together with a screwdriver.
- Pull the ends of the plastic loop that forms the base apart where they join.
- Move the array to one side either by a good landmark or in a cardinal direction for a fixed distance so that they are not lost.
- If an old array is being replaced, swim the old array to the surface.

NOTE: Stow the plates carefully on the skiff keeping each arm of the array intact (the black base tube may be removed) and leaving all marine growth on the plates. Place them in a freezer to be processed by a coral scientist. If no coral scientist is assigned on the cruise and space is a concern, separate the plates by the direction the array arm was pointing (N, S, E, W) and the orientation of the plates on that arm (horizontal or vertical). Label ziplock bags and waterproof paper tags (for inclusion in the bag with the plates), with this information and store them in the freezer.

Diving Operation Procedures
At this point, divers will be faced with one of the following scenarios for completion of the operation. The team should know which one is the case before departing the mothership for the operation.

1) Both an old buoy and anchor are present and both must be replaced.
Complete steps **A, B, C, D, E, F.**

2) Both an old buoy and anchor are present and just the buoy must be replaced.
Complete steps **A, C, D, E.**

4) An old anchor is present and it must be replaced and a new buoy installed.
Complete steps **A, B, D, E, F.**

5) An old anchor is present and a new buoy must be installed.
Complete steps **A, D, E.**

6) A new anchor and buoy must be installed.
Complete steps **A, B, D, E.**

NOTE - For scenarios involving both steps A and B: If the buoy and anchor have been towed to the site at the same time, then the first two steps should be performed in order. If they're towed in separately, tow the anchor in before the buoy and reverse the order of the first two steps.

A) Stage the new buoy.
- With the skiff positioned as described above, pull in the towline to the new buoy and secure it to the bow of the skiff so that it is out of the way.

B) Lower the Anchor.
- With the skiff positioned as described above, shorten the towline to the anchor so that it is floating a few feet to either side of the old buoy and tie it off to a cleat.
- Divers don gear, prep their assignment and take position.
- The Coxswain unties the towline from the cleat, but holds onto the line to assist the lift bag operator in maintaining position.
- The lift bag operator gives the "OK" signal to and receives it from each diver, one at a time, to initiate the descent. The coxswain lets line out without keeping any tension on it.
- Lower the anchor to the bottom placing it right next to the old anchor.
- Entirely deflate the lift bag.

C) Remove the old buoy and accumulator from the anchor.
- Run a line from the stern of the skiff to the buoy and tie each end securely.
- Switch the lift bag from the old anchor to the new anchor. Attach it to the ¾" shackle that connects the accumulator to the anchor. The anchor's padeye is unusable because it is full of the 3/4" shackle.
- The lift bag operator gives and receives the "OK" signal to/from each diver before beginning to fill the lift bag. Slowly begin to fill the lift bag. Stop filling the lift bag while the whole rig is still a bit negatively buoyant. The lift bag operator gives and receives the "OK" signal to/from each diver to indicate the load is about to rise, then raises the anchor.
- Remove the shackle attaching the accumulator to the buoy.
- Return the anchor and accumulator to the bottom close to the new anchor utilizing the "OK" signal to initiate descent. Once on bottom, completely deflate the lift bag.

- Swim the old accumulator over next to the new one that is staged on the bottom and switch them out on the line to the surface.
- On the surface: move the buoy to the bow and secure it out of the way of the dive operations. It will be prepped for transport later.

D) Attach the accumulator to the anchor and the buoy.
- Swim the new accumulator over to the new anchor and attach the bottom end (without chain) to the anchor using two nestled ¾" shackles.
- Move the lift bag from the old anchor to the new attaching it to the ¾" shackle running through the anchor's padeye.
- Nestle the loops (the "U" shaped piece) of a 5/8" and a 1 ¼" shackle and then run the bolt of the 5/8" shackle through either the top link of the chain or the top shackle on the buoy end of the accumulator. The loop of the 1 ¼" shackle will now be secure enough to not fall out. Pocket the bolt, nut and cotter pin of the 1 ¼" shackle. (This shackle prep could be done before the dive.)
- Run a 40 ft connector line from the top shackle on the accumulator through the padeye on the bottom of the buoy. Tie it off with an easily undone knot.
- The lift bag operator gives and receives the "OK" signal to/from each diver before beginning to fill the lift bag. Slowly begin to fill the lift bag. Stop filling the lift bag while the whole rig is still a bit negatively buoyant. The lift bag operator gives and receives the "OK" signal to/from each diver to indicate the load is about to rise, then raises the anchor.
- Use the connector line to pull the end of the accumulator up to the bottom of the buoy.
- Attach the accumulator by running the bolt of the 1 ¼" shackle (ref. two steps back) through the padeye on the bottom of the buoy.
- Return the anchor and accumulator to the chosen site on the bottom utilizing the "OK" signal to initiate descent. Once on bottom, completely deflate the lift bag.

E) (Re)Install settlement plate array and tape two remaining shackle nuts.
- With the base loop of the array already running through the bottom PVC conduits, wrap the base of the array around the anchor, connect the ends of the base loop with the plastic insertion piece, and tighten the hose clamp.
- Rest the loose ends of the PVC array arms on the anchor. They should meet around the padeye of the anchor with the corners of the array arms touching. Use 10" zip ties to connect the corners of the arms together and then connect each arm to the anchor padeye.
- Wrap electrical tape around the nut and cotter pin of the two shackles that still need it.

F) Raise the old anchor and secure.
- Attach the lift bag to the anchor padeye.
- The lift bag operator gives and receives the "OK" signal to/from each diver before beginning to fill the lift bag. Slowly begin to fill the lift bag. Stop filling the lift bag while the whole rig is still a bit negatively buoyant. The lift bag operator gives and receives the "OK" signal to/from each diver to indicate the load is about to rise, then raises the anchor.
- On the surface: fill the lift bag to capacity and secure the anchor to the side of the stern of the vessel. It will be prepped for transport later.

Operational Wrap-up
At this point, SCUBA diving operations are complete, but the following tasks still need to be accomplished.

Lower and secure the subsurface mast (2 people).
Note: For this task, it helps to have one person (relatively short and light) sitting/crouching on the float deck of the buoy and one in the water with mask, fins and snorkel.

Lower the ss mast.
- Remove the bolt securing the bottom of the subsurface mast to the main mast.
- Remove the bolt that is not securing the ss mast to the base plate and stow it.
- Loosen the bolt that is securing the ss mast to the base plate.

- Lower the ss mast by passing from the person on the float deck to the person in the water. The buoy will list severely to the side, which serves as an advantage in lowering the mast. Just hang on tightly to the main mast and avoid dropping the ss mast.

Secure the ss mast.

- Remove the bolt securing the ss mast to the base plate.
- Align the holes in the base plate and the ss mast plate so that the ss mast lays flush in its groove – two of the tree sets will line up.
- Use the bolts and nuts that have been safely stowed to join the plates.

<u>Attach bird deterrents to instrument arm on main mast.</u>

- Attach 8" zip ties around all horizontal posts positioning them vertically and providing a 3 – 4" spacing.
- Attach 36" zip ties to appropriate vertical posts positioning them so they are suspended over unspiked horizontal surfaces.

<u>Photodocument the new CREWS assembly.</u>

- Take photographs of the new mooring set-up. Take one or two close-ups of the accumulator connections to the anchor and buoy, the settlement plate array and the subsurface mast. Take some photos at distance (as allowed by visibility) of the entire mooring system both above and below water.

<u>Record Data</u>

- Take a two or three GPS positions of the deployment, even if it's a replacement.
- Fill out both the "Dive" and "Navigation" metadata sheets.

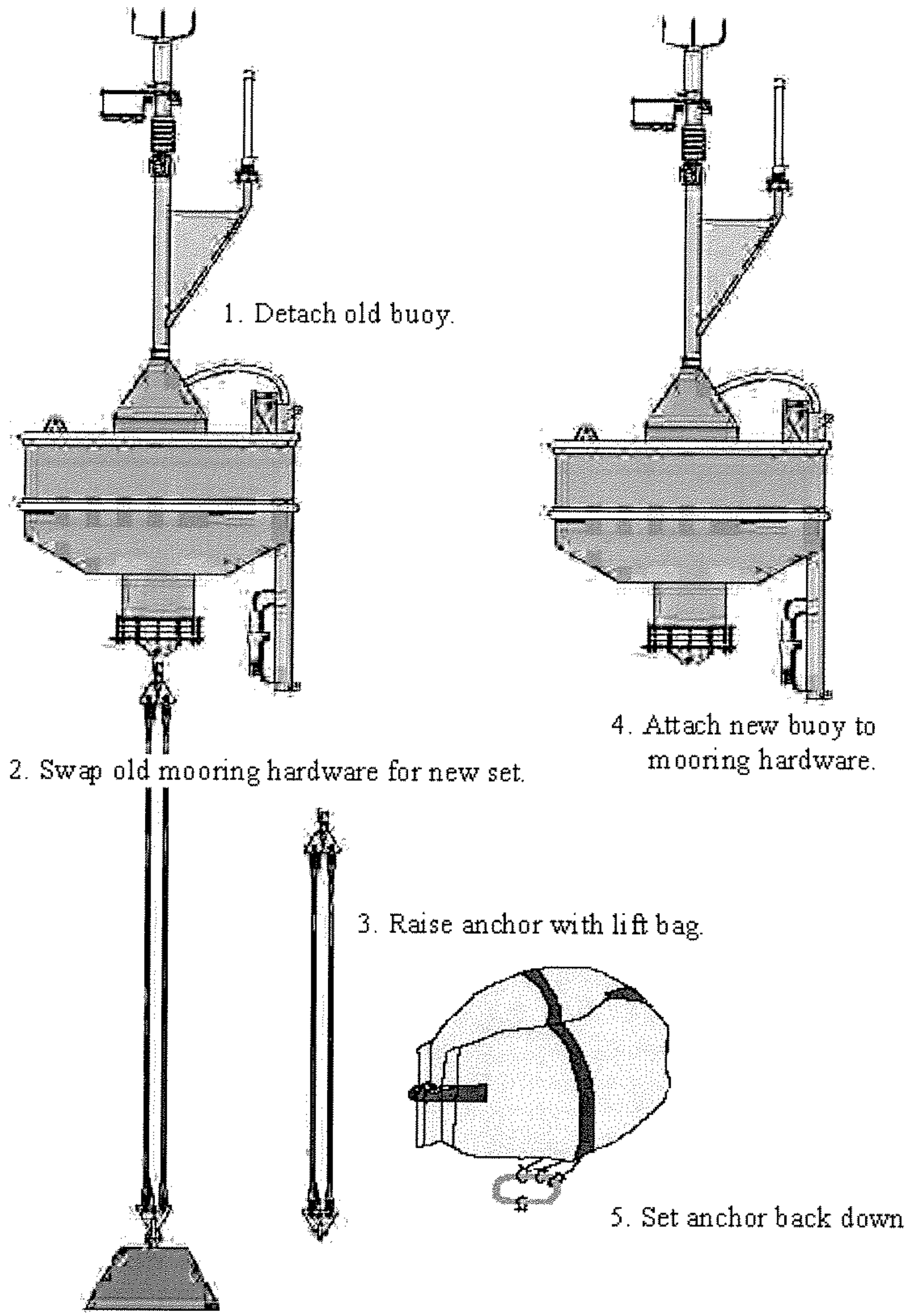


Figure 1: CREWS buoy protocol.

Appendix B

CRED Dive Protocol:
ODP

Written by: Stephani Holzwarth
Date: 3/2003

EQUIPMENT:

1-2 small boats
1 set of dive gear + 80 cf air tank per diver
1 visual signaling device per diver (telescoping flag or safety sausage)
1 portable, waterproof oxygen kit

1 pelicase toolbox
- 2 crescent wrenches
- 1 stubby flathead screwdriver
- 1 pair of wirecutters (for clipping zipties)
- 1 pair of needlenose pliers
- 1 tube of aqua lube
- 1 roll of duct tape

2-3 small danforth anchors
1 GPS unit and navigation data sheet
1 2000 lb lift bag + 80 cf air tank + yoke + brass nipple fitting
1 6 inch oval brass ring with 4 steel shackles (to attach liftbag to odp)
2-3 taglines (15-30 feet long)

settlement plates + pvc framework
3m of ¾" hollow poly tubing + 2x #10 hoseclamps + ¾" insert coupler
8-10 zipties (15" long, heavy duty)
mini mesh toolbag (wirecutters, knife/razor, flathead screwdriver)

Optional:
Digital still or video camera

PERSONNEL:

3-4 working divers (including 1 safety diver)
1 dive supervisor (ie person in the boat)
1 coxswain
(1 team of 3-4 divers works best, with 1 person operating the liftbag and 2 swimming the odp to its resting site, + 1 person in the boat to monitor for gear or divers coming to the surface)

DIVE PLAN:

Goal of the Operation: The goal of this operation is to deploy an Ocean Data Platform (see Figure 1), either in a location occupied previously by an ODP or in a new location.

Summary of the Operation: Deploying an ODP can be a simple or complex task, depending on ocean conditions, especially current and visibility, and on how close the ship or small boat can get to the site. The deployment dive is anticipated to take from 20 to 30 minutes (usually all that is allowed on dive tables if the ODP site is 80-100 ft. deep), once the ODP is on site. An additional 20 minute dive may be needed to install the settlement plates, and a 15 to 20 minute dive may be needed prior to deployment to mark the site with a buoy.

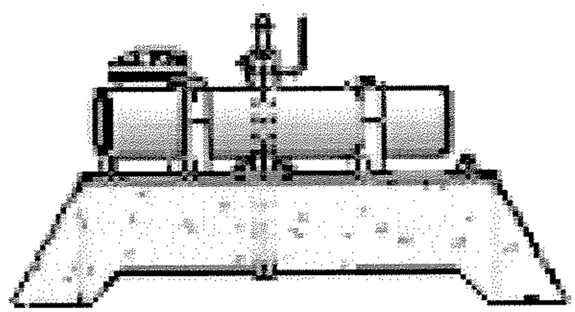
Getting the ODP to the site can be accomplished in 2 ways- by ship or small boat. If the surrounding water is deep enough, the ODP (with an un-inflated liftbag and a line with a marker buoy attached) can be lowered from the deck to the water, where it is released using a quick-release j-hook. The ODP will end up on the bottom, hopefully very close to the chosen site, or at least upstream of a suitable site. Care must be taken not to drop it in water that is too deep for the divers to recover it (<130 ft). If the ship cannot drop the ODP at the site, we use a small boat to tow it on an inflated liftbag to the site (marked with a buoy on an anchor set earlier). If a current is present, it seems to work best to deploy the divers and ODP/liftbag upstream of the site and drift down to it. The liftbag operator must be skilled at attaining and retaining neutral buoyancy with the ODP on the liftbag to avoid "bouncing" the heavy object along the bottom, and crushing reef. The other 2 divers swim with 2 taglines, guiding the ODP to the site. The small boat can drop anchor or live-boat the operation, which ever is deemed more appropriate given the local conditions.

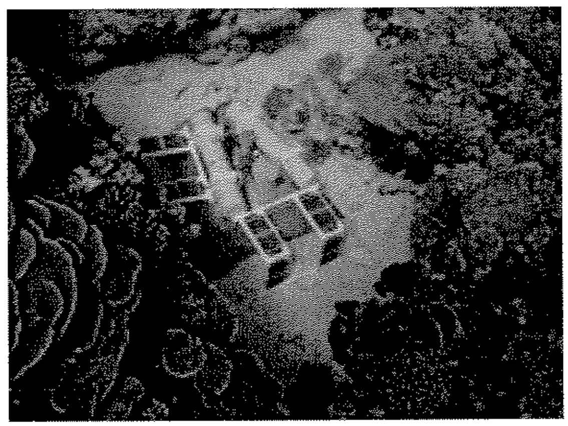
If an ODP is already present, the operation is potentially simpler since the 1400 lb concrete anchor can remain in place on the bottom. Settlement plates are removed. The instrument/battery section of the ODP is removed by pulling out a stainless steel pin and sliding the section up off the pin. The new instrument/battery section can be towed with a 500 lb liftbag, and divers will descend to the site and slide it onto the concrete anchor block. New settlement plates are assembled.

List of Tasks:

1. Choose the site for the new buoy.
2. Transfer the ODP (on an inflated 2000 lb liftbag) from the ship's deck to the water.
3. Tow with a small boat to the previously chosen site.
4. During the transit (or beforehand on deck) prepare the mooring hardware: coat all shackle pins (and cotter pins) with aqualube and wrap in electrical tape.
5. Position the boat near the buoy site (usually it works best to drop anchor).
6. Record GPS position, depth, divers present and any other pertinent information on the appropriate data and meta-data sheets.

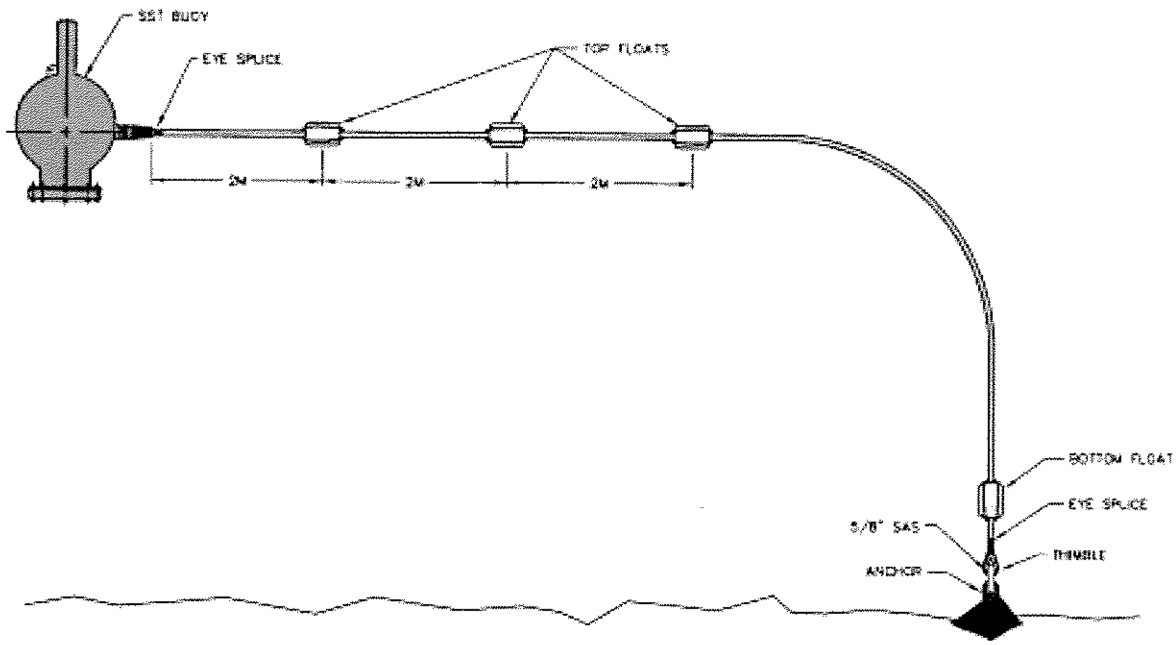
Figure 1: ODP (Ocean Data Platform) Instrument Array.





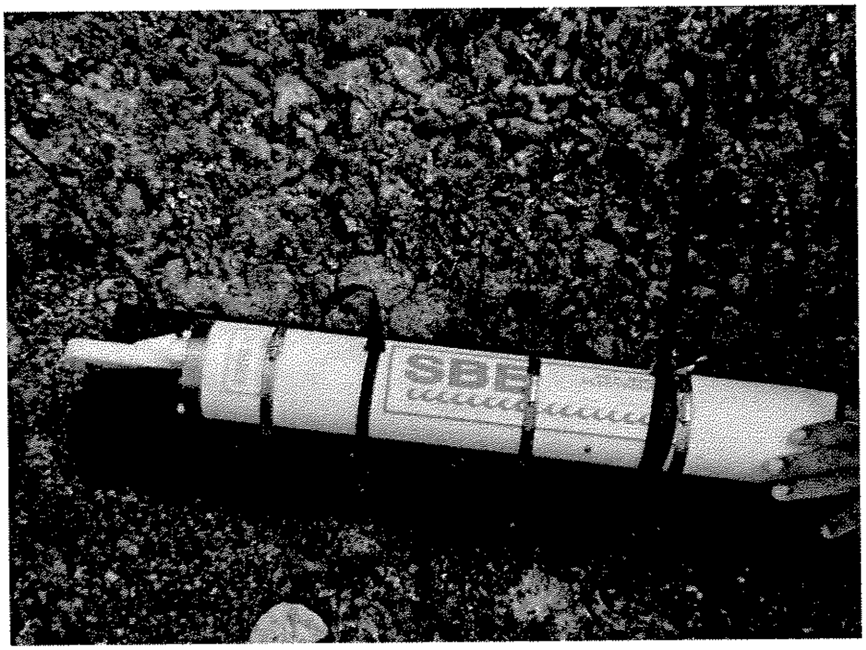
Appendix C

Diagram of SST (Sea Surface Temperature) mooring and anchor system.



Appendix D

Photograph of WTR (Wave and Tide Recorder) mooring and anchor system.



Appendix E

Photograph of STR (Subsurface Temperature Recorder) mooring and anchor system.

U.S. FISH AND WILDLIFE SERVICE
Research/Management Study Proposal
Hawaiian Islands National Wildlife Refuge

1. **Name and Address of the Applicant:**

Rusty Brainard
Chief, Coral Reef Ecosystem Division
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2. **Title:** Quantitative assessment and monitoring of shallow reef fish assemblages in the Hawaiian Islands National Wildlife Refuge

3. **Background:** Quantitative assessment and monitoring of shallow reef fish assemblages is conducted around the US Pacific Islands as an integral part of the NOAA/NMFS/PIFSC Coral Reef Ecosystem Division's mission to improve our scientific understanding of these fish resources. As fish are the primary sustainable living resource on Pacific coral reefs, results contribute to the scientific basis essential for sound management.

   An initial species inventory was a prerequisite for comprehensive assessment of reef fish assemblages in each area. Subsequent biennial monitoring surveys are planned for each geographic sub-region to document temporal variability in reef fish assemblages. Habitat types surveyed included mainly outer reef slopes around most islands, but also included lagoon patch reefs, bays, back-reefs, and shallow oceanic banks, where present.

   Inventories and assessments of shallow reef fishes have been completed by CRED at all US Pacific Islands, where access is possible, and monitoring has been initiated. Ongoing analysis of this growing database will enable species-specific numerical and biomass densities to be calculated, fish assemblage structure to be described at various spatial and temporal scales, and statistical correlations to be determined. Further analysis of CRED's oceanographic and biological data will aid in understanding patterns of fish distribution and abundance as well as ecosystem associations.

4. **Objectives:** Objectives include: creating a fish baseline (e.g., that can be used to measure MPA effectiveness); monitoring size-frequency assemblages; assessing the status of target, indicator or keystone species; assessing response by fish community to possible ecosystem impacts (e.g., fishing, ecotourism, pollution habitat

damage, sedimentation, hurricanes); and assessing species composition and diversity, by area, and effectiveness of temporal monitoring of managed areas.

5. Justification: Quantitative assessment and monitoring of shallow reef fish assemblages is conducted around the US Pacific Islands as an integral part of the NOAA/NMFS/PIFSC Coral Reef Ecosystem Division's mission to improve our scientific understanding of these fish resources. As fish are the primary sustainable living resource on Pacific coral reefs, results contribute to the scientific basis essential for sound management.

6. **Procedure:** A. Permits: No permits other than a USFWS Special Use Permit are necessary.

B. Methods.

1. Study area: Studies will occur at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Lisianski Island/Neva Shoals and Necker Island.
2. Techniques: Several complementary, noninvasive underwater-surveys are used to enumerate the diverse components of diurnally active shallow-water reef fish assemblages. Survey types include: 1) Rapid Ecological Assessments (REA)- to document simple species presence at a station or reef/bank; 2) Belt Transects (BLT)- mainly to quantify relatively small-bodied and abundant fishes; and 3) Stationary Point Counts (SPC)- to quantify relatively larger (>25 cm Total Length [TL]) and more vagile fish species. Each method is replicated at sites within and/or among the various habitat types present around each island or bank. Fish length-class is estimated for all quantified fish to provide an estimate of numerical size structure and biomass densities by taxa.

a. REA surveys: A pair of diver-observers conducts a random swim throughout the selected station area, recording the presence of fishes visually encountered by species or lowest recognizable taxon. This method is typically used at deeper, time-limited sites or where current is too strong to conduct transects. The REA protocol is also used following completion of a belt-transect or SPC, dive time permitting. The REA data complement the other visual protocols to assemble more complete reef-and archipelago-specific fish species inventories at each island or bank.

b. Belt transects: A pair of scuba diver-observers conducts parallel swims along three 25 m long transect lines, recording size-class specific (TL) counts of all fishes encountered, to species-level where possible, within visually estimated but defined belt widths: 4 m wide for fishes > 20 cm TL (100 m2 area) on the initial swim-out, and 2 m wide for fishes <20 cm TL (50 m2 area) on the subsequent swim back. Transects lines are typically set at depths of 10-15 m. Reef ledges and holes are visually searched. Stations are completed on all sides of the island/atoll, weather and sea conditions permitting.

c. Stationary Point Counts: One SPC diver-observer conducts surveys in conjunction with, but at least 10 m away from, the two belt-transect divers. All fishes >25 cm TL are recorded to species-level that entered a 20 m diameter cylinder (area ~314 m2) during a timed 5 minute count. Individuals or groups are estimated to the nearest 5 cm TL size-class bin. Four replicate, 5 minute cylinder counts are conducted at each station. Care is taken to avoid over-counting large transient or schooling species.

d. Fish Collections: No collections of fish specimens on these cruises are planned, at present.

D. FWS staff and space needs: No assistance is required by USFWS staff.

E. Hazmats: No hazardous materials are required.

7. **Personnel:** TBD

8. **Costs:** No costs will be incurred by the USFWS in order to conduct this study.

9. **Schedule:** The cruise will depart August, 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

10. **Transportation:** The NOAA Ship *Hi'ialakai* will provide transportation to and from the National Wildlife Refuge System locations.

11. **Reports:** A summary report of mapping accomplishments will be submitted to USFWS by September 2006.

12. **Publications:**

Significant results of CRED fish surveys from the Northwestern Hawaiian Islands National Wildlife Refuge Complex will be disseminated to the public through presentations at scientific symposia (oral or poster), local, regional and national-level monitoring reports, and in scientific publications. (See below for a partial listing of publications from our earlier work in the NWHI.) In addition, summary information will be available on our website and metadata records referencing the original data will be submitted to NOAA's Coral Reef Information System (CoRIS).

13. **Relevant Publications**:

DeMartini, E.E. (in press?) NWHI Reef Fishes, NOAA Technical Report, editor, Alan Friedlander, NOAA NOS.

DeMartini, E.E., and A.M. Friedlander (in press?) Is localized re-seeding, net upchain transport, or some post-settlement process the cause of the spatial distribution of endemism in Northwestern Hawaiian Island reef fishes? Mar. Ecol. Progr. Ser.

Holzwarth, S.R., B.J. Zgliczynski, and R.E. Schroeder. (in press) Spatial distributions of large mobile predators in the Northwestern Hawaiian Islands. Proc. 10th Int. Coral Reef Symp., Okinawa, Japan.

Schroeder, R.E., and J.D. Parrish. (in press) Ecological characteristics of coral patch reefs at Midway Atoll, Northwestern Hawaiian Islands. Atoll Res. Bull. Vol. 543 (Proc. 3rd NWHI Sci. Symp.)

Schroeder, R.E., and J.D. Parrish. 2005. Resilience of predators to fishing pressure on coral patch reefs. Jour. Exper. Mar. Biol. & Ecol. 321/2:93-107.

DeMartini, E. E. 2004. Habitat affinities of recruits to shallow reef fish populations: selection criteria for no-take MPAs in the NWHI Coral Reef Ecosystem Reserve. *Bull. Mar. Sci.*74:185-205

DeMartini, E.E., and A.M. Friedlander. 2004. Spatial patterns of endemism in shallow-water reef fish populations of the Northwestern Hawaiian Islands. *Mar Ecol Prog Ser* 271:281-296

Mundy, B.C., Parrish, F.A. (2004) New Records of the Fish Genus Grammatonotus (Teleostei: Perciformes: Percoidei: Callanthiidae) from the Central Pacific, Including a Spectacular Species in the Northwestern Hawaiian Islands. *Pac Sci* 58(3): 403-417

Brainard, R., A. Friedlander, D. Gulko, C. Hunter, R. Kelty, and J. Maragos. 2003. Status of Coral Reefs in the Hawaiian Archipelago. In: *Status of Coral Reefs of the World*: 2002. C. Wilkinson, ed. Australian Institute of Marine Science, pp. 237- 250.

Holzwarth, S., R. Hoeke, and R. Brainard. 2003. Integrating multiple data sources acquired from towed diver surveys to assess and map coral reef ecosystems of the U.S. Pacific Islands. [Abstr] *Coastal GeoTools '03*, Charleston, SC. Jan. 6-9, 2003.

DeMartini, E.E., F.A. Parish, and R.C. Boland. (2002) Comprehensive evaluation of shallow reef fish populations at French Frigate Shoals and Midway Atoll, Northwestern Hawaiian Islands (1993/93, 1995-2000). NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-347. December 2002.

Friedlander, A.M., and E.E. DeMartini. (2002) Contrasts in density, size, and biomass of reef fishes between the northwestern and the main Hawaiian islands: the effects of fishing down apex predators. Mar. Ecol. Progr. Ser. 230:253-264.

Russell E. Brainard ______________________ Date: 17 May 2006
Submitted by:

______________________ Date: ____________
Wildlife Biologist (Concurrence)

______________________ Date: ____________
Refuge Manager (Approval/Concurrence)

The following , if required:

______________________ Date: ____________
Refuge Complex Manager (Approval/Concurrence)

______________________ Date: ____________
Project Leader (Approval/Concurrence)

______________________ Date: ____________
Regional Office (Approval/Concurrence)

Long-term Monitoring of Bottomfish Populations Using Autonomous Camera Bait Stations in the NWHI

1. **Name and Address of the Applicant:**

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2. **Background:** An autonomous deep-water (500m) camera bait station to be used as a cost-effective non-extractive method to assess and monitor exploited bottomfish populations is being developed. These camera bait stations will be deployed on a short-term basis (less than 48 hours) at various sites in the NWHI State Marine Refuge to collect initial data about the bottomfish species diversity and abundance.

3. Objectives:
This work will help to further the understanding of the relative population dynamics of bottomfish within the Refuge with out the need for extractive or destructive sampling. While most reef fish surveys are conducted in shallow reef areas (0 - 20m), many commercially and functionally important species are bottomfish that inhabit the less accessible deeper reef areas. Periodic assessments and monitoring of these important species is required in order to assess the impact of bottomfishing, support ecosystem-based management, and to determine the effectiveness of the Refuge and other nearby Marine Protected Areas.

4. Procedures and Methods:

i. Study Area:
Studies will occur at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Lisianski Island/Neva Shoals and Necker Island.

ii. Techniques:
The Botcam is an open aluminum frame which houses a number of electronic and mechanical components that provide stereo videography, video storage, self-contained battery power, mooring ball, two radio beacons and strobes, a radar reflector and flag, acoustic release for buoyant retrieval, a temperature and pressure recorder, an automated bait release system, and integrated floatation. The size and weight of the entire array are:

External Dimensions of Frame (without bait arm): 48" x 22" x 18"
Bait Arm Length: 48"
Weight (in air): 150 lbs
Weight (in water): 10 lbs buoyant
Anchor Weight (in water): 100 lbs minimum

Figures 1 through 3 below are schematic drawings of the deployed Botcam system.

Figures 4 and 5 below are photographs of the deployed system.

The Botcam is to be deployed in bottom fish habitat between 150 and 350 meters depth. Generally, these areas are in high rugosity, steep slope environments. On the deepest deployments, up to 500 meters of surface line will be attached to the unit. On all deployments, a minimum of 75 meters of surface scope will be added in order to minimize wave influence on the deployed Botcam.

The Botcam unit and acoustic release are buoyant and the system is designed to float between 2 and 3 meters off the bottom and to self align down current. This distance also helps to minimize the risk of snagging the Botcam components and/or frame on the bottom. The system must be made negatively buoyant with concrete anchors. Approximately 300 lbs. (in air) of concrete are to be used per drop. This volume of concrete is approximately an 18 inch cube.

The standard method of Botcam recovery is to command to the acoustic release unit (pictured in figures 4 and 5) to release the equipment payload allowing it to float to the surface. The cement anchors and a short section of natural fiber sinking anchor line on the bottom. The anchors are sacrificed because it is thought that more damage will be done to the benthic habitat in attempting to pick the anchors from depth given the amount of scope on the surface line that is necessary. Because they will remain on the bottom, cement anchors were chosen because of the inert nature of cement and the relatively benign effect that they will have on the environment. The reason that the anchors are not retrieved is that vessel drift and variable currents throughout the water column make it extremely difficult to pick the Botcam system vertically off the bottom. Any attempt to do so would likely lead to the anchors and possibly the equipment itself being dragged across the bottom thus risking damage to both the benthos and the equipment.

iii. Analysis:

Botcam is a notable improvement upon earlier camera bait stations because it provides the means to not only estimate relative abundance and species composition of target fish, but also their size. Stereo images of fish that are attracted to the bait are recorded by the Botcam. These stereo-video images are processed using a software package called Vision Metrology System (VMS) from Geomsoft (www.Geomsoft.com). Objects (e.g. fish) that can be seen in both the left and right images are measured by clicking on the same points in both images and then choosing the object's name from a pull down menu. The length of the object is projected on both images. The objects distance and angle from the cameras, the frame number (time) and the X, Y, Z coordinates in space are all reported in a data file that can be uploaded to alternative data management programs (e.g. Microsoft Excel, Matlab).

VMS has been tested in several underwater applications by Dr. Euan Harvey from the University of Western Australia and others. Results from Harvey et. al. (2003) using caged Blue Fin Tuna show that stereo-video measurements compare favorably to physical measurements of the fish taken with calipers after being removed from the cages.

In early work with camera bait stations in productive regions, statistical methods of analysis were established and tested by Ellis and DeMartini (Ellis and DeMartini 1995). They used 4 parameters: time to first arrival of a target fish (TFAP), maximum number counted in any frame (MAXNO), total duration in sequence (TOTTM), and species present and duration of bait attachment (BTM).

In their tests, they found that the maximum number (MAXNO) parameter correlated best to the traditional catch per unit effort (CPUE) parameter used in fishing surveys. Use of the MAXNO parameter avoids the potential problem of counting the same fish multiple times as it exits and re-enters the camera's field of view and yields conservative relative density estimates. We will employ the most suitable analysis methods based on the final sampling opportunities.

iv. Interpretation

Methods for optimal interpretation of the video imagery are still being developed, and cooperative efforts between HURL and CRED should provide a standardized methodology to determine relative abundance of bottomfish for each study site.

5. Personnel: The Principal Investigators for the proposed bottomfish study will be Dr. Michael Parke, Fishery Biologist for the Coral Reef Ecosystem Division (CRED) at the NOAA Pacific Islands Fisheries Science Center and Dr. Chris Kelley of the Hawaii Undersea Research Laboratory at the University of Hawaii. Additional participants will include Daniel Merritt, Virginia Moriwake.

6. Schedule: The cruise will depart August, 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

7. Transportation: All personnel will be transported onboard the NOAA vessel *Hi'ialakai.*

8. Reports: A report of all activities carried out under the permit authority will be submitted in a timely fashion after the conclusion of each leg of the cruise. The reports will include the dates of all arrivals and departures from islands and atolls within the Refuge Complex, names of all persons involved, and preliminary results of field survey activities.

9. Relevant Publications:

Cappo, M., Harvey, E., Malcolm, H., and Speare, P. (2002). Potential of video techniques to monitor diversity, abundance and size of fish in studies of marine protected areas. *ASFB Australia 2003.*

Ellis, D. M., & DeMartini, E. E. (1995). Evaluation of a video camera technique for indexing abundances of juvenile pink snapper, pristipomoides filamentosus, and other hawaiian insular shelf fishes. *Fishery Bulletin, 93*(1), 67-77.

Harvey, E., Cappo, M., Shortis, M., Robson, S., Buchanan, J., & Speare, P. (2003). The accuracy and precision of underwater measurements of length and maximum body depth of southern bluefin tuna (thunnus maccoyii) with a stereo-video camera system. *Fisheries Research (Amsterdam), 63*(3), 315-326.

Harvey, E., Fletcher, D., & Shortis, M. (2002). Estimation of reef fish length by divers and by stereo-video: A first comparison of the accuracy and precision in the field on living fish under operational conditions. *Fisheries Research (Amsterdam), 57*(3), 255-265.

Harvey, E., Fletcher, D., & Shortis, M. (2001). A comparison of the precision and accuracy of estimates of reef-fish lengths determined visually by divers with estimates produced by a stereo-video system. *Fishery Bulletin, 99*(1), 63-71.

Kelley, C & R. Moffitt (2004). "The impacts of bottom fishing on the Raita and West St. Rogatien Reserve Preservations Areas in the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve." NOS Final Report.

Somerton, D. & Gledhill, C. (2005). Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis. *August 4-6, 2004*, Alaska Fisheries Science Center. Seattle, WA.

Willis, T. J., Millar, R. B., & Babcock, R. C. (2000). Detection of spatial variability in relative density of fishes: comparison of visual census, angling, and baited underwater video. *Mar.Ecol.Prog.Ser, 198*, 249-260.

Russell E. Brainard — Date: 15 May 2006
Submitted by:

____________________ Date:________
Wildlife Biologist (Concurrence)

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Refuge Manager (Approval/Concurrence)

The following , if required:

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Refuge Complex Manager (Approval/Concurrence)

____________________ Date:________
Project Leader (Approval/Concurrence)

____________________ Date:________

Regional Office (Approval/Concurrence)

Figures

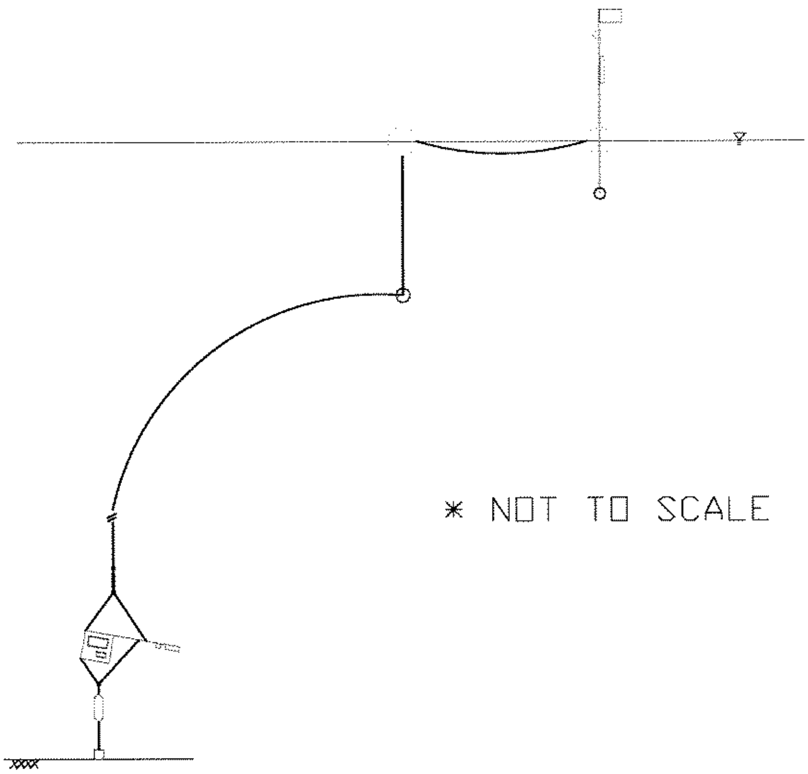

Figure 1. Schematic - Botcam, Surface Line and Surface Signature

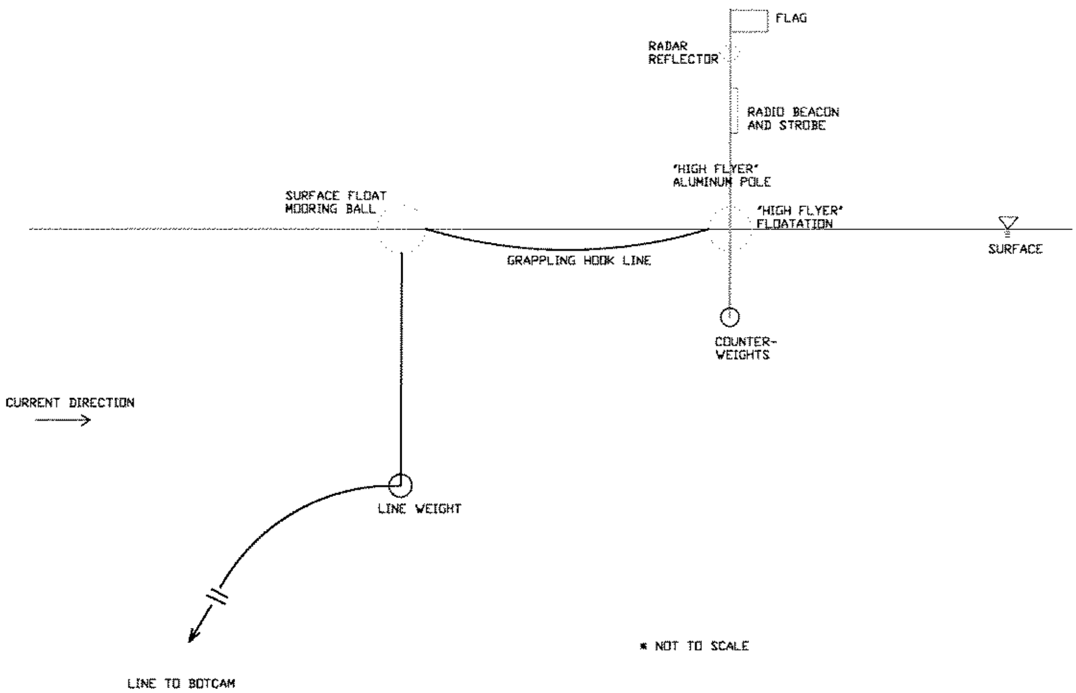

Figure 1. Schematic - Surface Signature

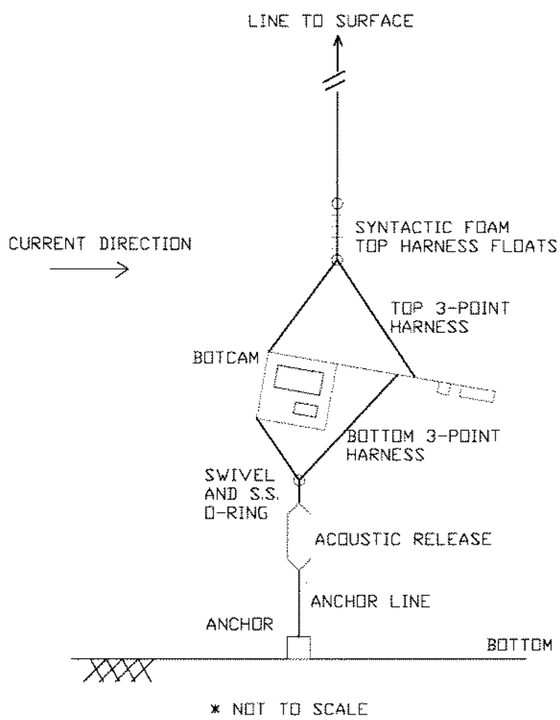

Figure 3. Schematic - Botcam Deployed on Bottom

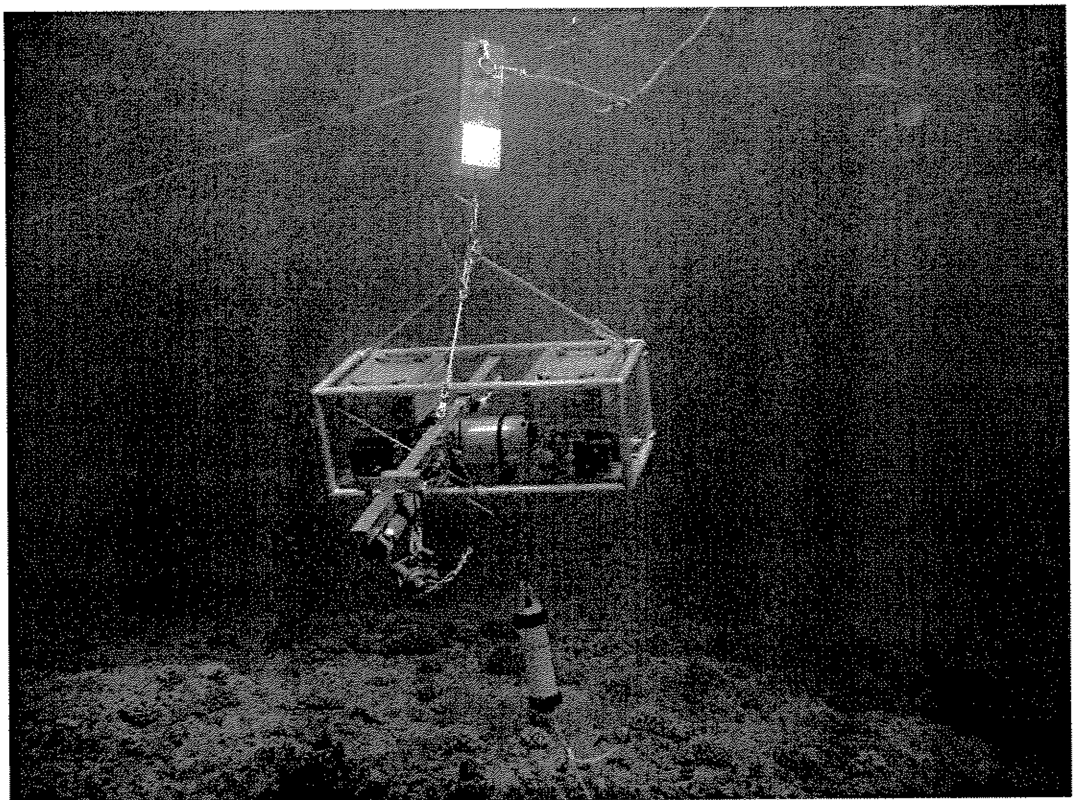
Figure 4. Shallow Water Photo of Botcam with Acoustic Release and Anchor Line Below

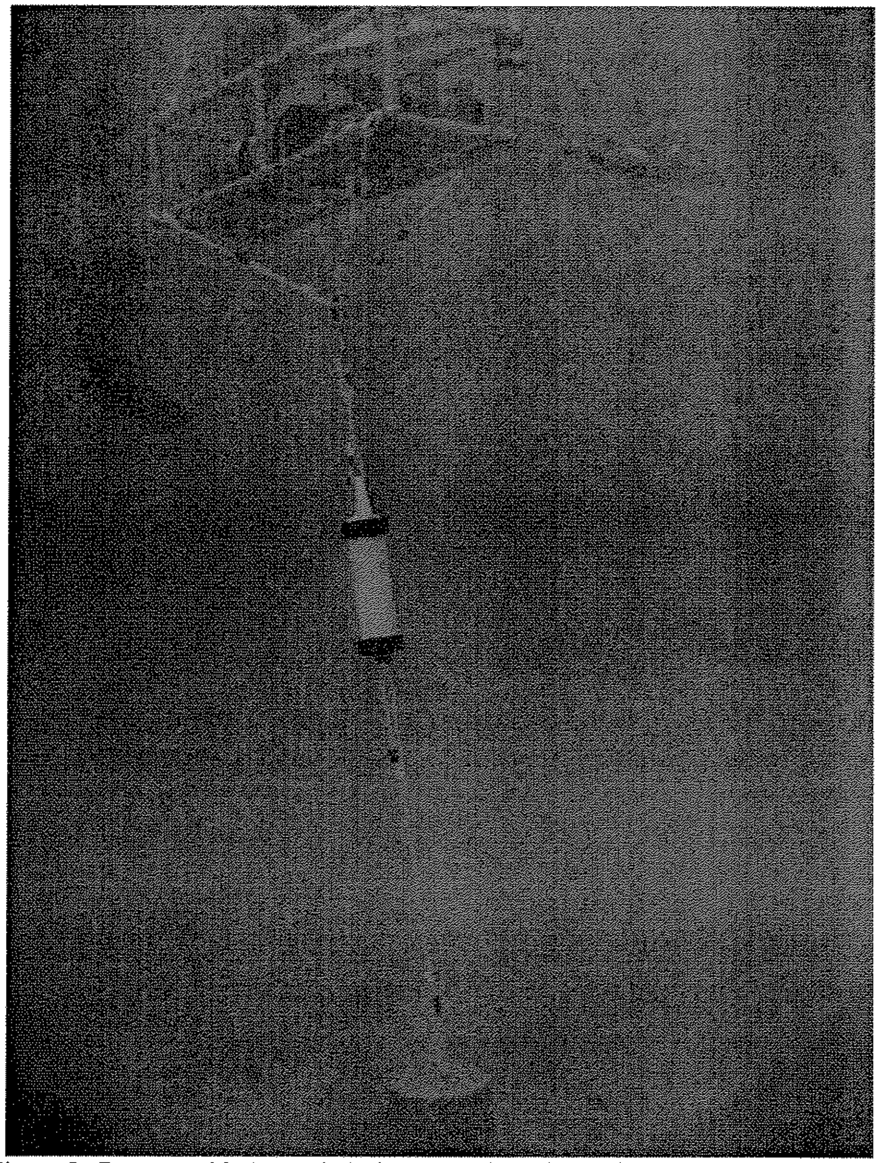

Figure 5. Botcam with Acoustic Release, Anchor Line and Concrete Anchor Below

U.S. FISH AND WILDLIFE SERVICE
Research/Management Study Proposal
Hawaiian Islands National Wildlife Refuge

1. **Name and Address of the Applicant:**

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2. **Title:** Collection of corals associated with assessing and monitoring reefs within the Hawaiian Islands National Wildlife Refuge

3. **Background:**

Coral Disease: Global climate change and human activities are placing coral reef ecosystems at risk. Coral reefs worldwide are now declining at an alarming rate. Mass bleaching events have increased dramatically since the 1980's with an equally alarming increase in the incidence of coral disease. In the Florida Keys, Porter et al. (2001) report that between 1996 and 1998 the number of survey stations containing diseased individuals increased by 265%. They also report dramatic increases in the number of different coral species exhibiting disease. Coral disease has also been reported to be responsible for the dramatic decline of acroporids, one of the major frame-building corals in the Florida Keys, changing the structure and function of the coral reef ecosystem (Aronson & Precht 2001). Despite the major impact disease can have on reef systems, the etiology of most coral diseases remains unclear (Santavy and Peters 1997, Richardson 1998). The causative agents, mechanisms of pathogenesis and links to environmental or anthropogenic stress are still largely unknown (Richardson 1998, Green & Bruckner 2000). In 2002 we began to document baseline levels of coral bleaching and disease in the NWHI and extended those investigations to Johnston Atoll, Howland, and Baker Islands in 2004 and 2006. In 2006, disease assessments were initiated in American Samoa (including Rose Atoll NWR), Jarvis NWR, Palmyra Atoll NWR, and Kingman Atoll NWR. We would like to continue such investigations at the Hawaiian Islands National Wildlife Refuge (NWR). This will give us a broader understanding of what factors may be affecting the incidence of bleaching and disease in corals.

Taxonomic Records: During previous scientific cruises that occurred between 2000 and 2004 undertaken by the applicant(s) within the Hawaiian Islands National Wildlife Refuge, new records have been made of coral species' occurrence and possible new species. The confirmation of range extensions of described species requires collecting small samples for verification by additional taxonomic experts, as does the collection of type specimens for describing possible new species.

Permanent Transects: A number of permanent transects have been established at fixed sites during previous cruises, with the intention of providing georeferenced markers by which researchers can return to precise locations on subsequent cruises so as to re-survey the reef at known time intervals. Additional permanent transects may be established in

2006, and any markers that have become dislodged since their installation would need to be replaced/repaired. Previously-established as well as newly-established permanent transects may be surveyed in 2006.

4. Objectives:

(1) Obtain a baseline assessment of the abundance and distribution of diseased corals at most of the major atolls and islands within the Hawaiian Islands NWR;
(2) Build on observations of the abundance and distribution of diseased corals at Hawaiian Islands NWR that were initiated in 2003;
(3) Systematically describe gross and microscopic morphology of disease in Pacific corals.
(4) Verify range extensions of described species of corals, and procure type specimens for the description of new species.
(5) Establish and survey additional permanent transects for coral re-surveys in future years, and replace/repair and resurvey existing transects and markers.

5. Justification:

Coral Disease: Outbreaks of novel diseases have occurred in the world's oceans. Mass mortality of sea fans occurred in reefs of the Caribbean and Florida Keys. The pathogen *Aspergillus* was thought to be a new species that originated from terrestrial sources (Smith et al., 1996, Rosenberg and Ben-Haim 2002). White pox, a lethal disease of *Acropora palmata*, was first documented on the reefs in 1996 and was found to be caused by a common fecal enterobacterium found in the human gut (Patterson et al. 2002). Current models of global climate change predict a significant increase in sea surface temperature (Kleypas et al. 1999, Walker 2001). Elevated temperatures have been shown to accelerate the growth rate and virulence of pathogens (Porter et al., 2001) and so it has been predicted that coral disease will become even more common and widespread (Porter et al. 2001, Rosenberg and Ben-Haim 2002). An outbreak of coral disease was documented on the near-pristine reefs at French Frigate Shoals in the NWHI in 2004. This suggests that no reefs are immune to disease. It is critical that reef managers develop the necessary knowledge and diagnostic tools to assess coral health and, more importantly, to systematically approach diseases in corals to determine cause and effect. This knowledge will be critical if we are to effectively address coral disease outbreaks and provide appropriate management recommendations to resource biologists.

Taxonomic Records: Due in part to their geographic remoteness, the reefs within the Hawaiian Islands NWR are poorly known compared to reefs more regularly accessed by scientific investigators. A number of new records and possible new species were recorded during scientific visits between 2000 and 2004, and while the "discovery curve" is likely leveling off, it is still possible that new records and/or species will be observed in 2006. Scientific and management issues pertaining to biodiversity can only be properly addressed when the inventory of species known to inhabit an area is complete. While *in situ* photographs are invaluable diagnostic and documentary tools, the rigorous process of taxonomic verification requires inspection, study, and description of collected specimens.

Permanent Transects: Scientists were largely engaged in assessment activities on the reefs of the Hawaiian Islands National Wildlife Refuge (NWR) Complex during 2000, 2001, and 2002, and switched to monitoring activities in 2003. Monitoring relies in large part on choosing fixed sites and resurveying them using standardized protocols during subsequent surveys. Permanent transects along with non-permanent transects within fixed sites are complementary monitoring tools. Monitoring of fish and wildlife is also an established management responsibility within all NWRs.

6. Procedures:
A. Permits: New regulations by the State of Hawaii Department of Land and Natural Resources (DLNR) require formal approval from the Northwestern Hawaiian Islands State Marine Refuge to conduct the activities described above. A permit application is presently being reviewed by the State of Hawaii DLNR.

B. Methods:
1. Study Area: Studies will occur at Necker Island, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Lisianski Island/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll.

2. Techniques:
Coral Disease: To survey the sites, two 25 m lines will be laid out; one diver will videotape along both lines to determine coral cover by later, computer-assisted analysis. A second diver uses the line-intercept method at 50cm intervals along both transect lines (51 points/transect) to more rapidly determine benthic substrate composition (including coral cover). The first diver will then swim over the lines a 2nd time during which all corals within one meter of either side of the transect lines will be identified to species, counted, assigned to a size class (0-5cm; 6-10cm; 11-20cm; 21-40cm; 41-80cm; 81-160cm; >160cm.), and assessed as to extent and degree of bleaching. The second diver, who is a specialist in coral disease, concurrently examines all corals within three meters of either side of the transect lines for evidence of disease or bleaching. For corals exhibiting disease signs, the colony will be photographed, the condition will be described, and a small sample may be taken for histopathological analyses.

Taxonomic Records: Collections will be based upon provisional identification of candidate new records or undescribed species in the field. Each specimen will be carefully dislodged using a hammer and cold chisel, and placed in labeled bags together with site and depth location. No more than 2 type specimens will be collected for each suspected new coral species and some new records. Photographs will be collected of as many new records and species as time and logistics permit. In no case will specimens be collected if it is judged that doing so might inhibit the capacity of the taxon to replenish itself.

Permanent Transects: Establishing a permanent transect involves manual installation of hardened stainless steel stakes (12 stakes/50m transect) on hard dead substrate, away from living corals. An underwater epoxy applicator is then used to better affix the stake to the substrate. Each stake measures $3/8^{th}$ – inch diameter; similar stakes have been used successfully with no signs of corrosion over a 2-year period. All other equipment (hammers, epoxy applicators, transect tapes) will be removed from the reef at the completion of each survey.

3. **Analysis:**

Coral Disease: Abundance and incidence of bleached and diseased corals will be calculated for each site. Diseases will be described and categorized.
Taxonomic Records: Specimens will be sent or shared with other taxonomic experts for identification and/or description, and suitable samples deposited for reference in an appropriate institution (e.g., Bishop Museum, Honolulu).
Permanent Transects: Digital images are taken sequentially along the transect line and quantitatively analyzed for percent cover, frequency, median diameter, population size distribution, diversity and other parameters using computer-assisted digital imagery techniques.

C. Interpretation:

Coral Disease: This will produce an important baseline of information on normal bleaching and disease levels. This baseline can be used as a comparison allowing the detection of changes in coral health. Histopathology of samples of diseased corals will allow us to characterize microscopic morphology of the disease and will provide systematic evaluation of cellular changes that occur in disease, what tissues of the coral (calicoblast, gastrodermis, mesoglea, epithelium) are affected, and whether foreign organisms (bacteria, metazoa, protistans, viruses) are visible. Histopathology provides a "first cut" in disease diagnostics and allows the investigator to narrow down possible etiologies for further investigation.
Taxonomic Records: Patterns of biodiversity become more complete as records are added to species' inventories, and the processes that account for these patterns can be better inferred as complete records are compiled.
Permanent Transects: Comparison of data over time enables the detection of change; use of additional biotic and environmental data allows inferences regarding probable drivers of change to be made.

7. Personnel: The Principal Investigator for the proposed study on coral disease will be Dr. Bernardo Vargas-Angel, Coral Disease Specialist, NOAA Fisheries Coral Reef Ecosystem Division. The PI for the standardized coral surveys along non-permanent transect lines is Dr. Jean Kenyon, Marine Ecologist, NOAA Fisheries Coral Reef Ecosystem Division. The PI for the taxonomic records and permanent transects is Dr. James Maragos, Coral Reef Biologist, USFWS Honolulu

8. Costs: No costs will be incurred by U.S. Fish & Wildlife Service.

9. Schedule: The cruise will depart August 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

10. Transportation: All personnel will be transported to and from units of the Hawaiian Islands National Wildlife Refuge Complex onboard the NOAA vessel *Hi'ialakai.*

11. Reports: A report of all activities carried out under the permit authority will be submitted in a timely fashion after the conclusion of each leg of the cruise. The reports will include the dates of all arrivals and departures from islands and atolls within the Refuge Complex, names of all persons involved, and preliminary results of field survey activities.

12. Publications: Selected results from previous surveys of corals conducted through Coral Reef Ecosystem Division in the Northwestern Hawaiian Islands as well as the Pacific Remote Islands National Wildlife Refuge Complex have been presented as conference posters, oral presentations, national-level reports, and publications in refereed journals. It is similarly anticipated that important results stemming from research conducted under the requested permit in 2006 will be professionally disseminated within the national and international scientific community. Furthermore, metadata records by which the original data can be obtained will be prepared and submitted to NOAA's Coral Reef Information System (CoRIS).

13. Relevant Publications:

Aronson, R. B. and W. F. Precht. 2001. White-band disease and the changing face of Caribbean coral reefs. Hydrobiologia. 460: 25-38.

Green, E. and Bruckner, A. 2000. The significance of coral disease epizootiology for coral reef conservation. Biological Conservation. 96: 347-361.

Kleypas, J., Buddemeier, R., Archer, D., Gattuso, J., Langdon, C, and Opdyke, B. 1999. Geochemical consequences of increased atmospheric carbon dioxide on coral reefs. Science 284:118-120.

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Rosenberg, E., and Ben-Haim, Y. 2002. Microbial diseases of corals and global warming. Environ Microbio 4(6):318-326.

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Russell E. Brainard

Submitted by:

Date: 17 May 2006

____ Date:__________

Wildlife Biologist (Concurrence)

____ Date:__________

Refuge Manager (Approval/Concurrence)

The following , if required:

____ Date:__________

Refuge Complex Manager (Approval/Concurrence)

____ Date:__________

Project Leader (Approval/Concurrence)

____ Date:__________

Regional Office (Approval/Concurrence)

U.S. FISH AND WILDLIFE SERVICE
Research/Management Study Proposal
Hawaiian Islands National Wildlife Refuge

1. **Name and Address of the Applicant**

Rusty Brainard
Chief, Coral Reef Ecosystem Division
Pacific Islands Fisheries Science Center
1125-B Ala Moana Blvd
Honolulu, HI 96814

2. **Title:** Species inventories for non-coral marine invertebrates within the Hawaiian Islands National Wildlife Refuge

3. **Background:** The need for conservation of coral ecosystems throughout the world requires knowledge concerning the ecological requirements of species that make up the system, causes for the loss of any of the component organisms, and the requirements for the survival of remaining species. The collection of systematic information concerning what taxa are present, or biodiversity assessment, is a prerequisite for determining the factors previously mentioned. The task of conservation is further supported by an ongoing monitoring program, which uses the biodiversity assessment as its baseline for detecting changes through time.

   Historically, the biodiversity assessments and monitoring programs for coral reefs have focused strictly on the charismatic fauna such as corals and fish. The majority of biodiversity within coral reef communities is represented by cryptic cnidarian, sponge, mollusk, echinoderm, crustacean, annelid, bryozoan and tunicate fauna. Proper inventory of such taxa requires two factors: physical sampling and systematic expertise. Thus, the need for specimen collection at the remote locations within the Hawaiian Islands National Wildlife Refuge (NWR).

4. **Objectives:**
   1. Collect both quantitative and qualitative information for species present at all sites.
   2. Produce species inventories for all locations

5. **Justification:** The non-coral marine invertebrate fauna of coral reefs represents a group of animals that are numerically dominant in their habitat and in some cases represent taxonomic groups that are only represented in the marine environment. New species of marine organisms are being described all the time in extensively studied habitats such as coral reefs. In addition to these new species descriptions, the expansion of knowledge concerning the ranges of known species is also an important task that is integral for the spectrum of conservation ranging from single species up to the level of ecosystems.

Marine invertebrate collections housed in natural history collections throughout the world are the main source for the information mentioned above. These collections housed in museums and universities throughout the world are extensive but still there is ample room for augmentation and addition to these resources. The present knowledge concerning systematics of marine invertebrates comes from the study of preserved specimens in these institutions, which were provided by various historical expeditions and individual efforts that focused on the collection of biological specimens in a variety of habitats. No single institution has collections that achieve complete coverage of all taxonomic groups and habitats. This is why marine surveys are as important today as they were a hundred years ago.

In addition to providing resources for taxonomic pursuits, marine invertebrate surveys document species that have use as bioindicators. Variations in populations of some species groups can indicate subtle changes in environments based on the different physiological characteristics of the diverse assemblage of marine invertebrates in reef habitats. This baseline information combined with a continuous monitoring program at set intervals can detect physical and chemical changes such as pollution and sedimentation and biological changes such as alien species introductions.

6. **Procedure:**

A. Permits. No permits other than that which is presently being sought are necessary to conduct the proposed sampling.

B. Methods.

1. Study Area: Studies will occur at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Lisianski Island/Neva Shoals and Necker Island.

2. Techniques: Quantitative counts for specific target marine invertebrates are done along two separate 10X25 meter belt transects. Additionally, ten .25m^2 quadrats are enumerated for each 10X25 meter belt transect to determine the average percent cover of certain sessile target species or for sub-sampling large populations of semi-mobile species (eg., boring urchins).

Based on data from previous rapid ecological assessments, a group of target species was chosen for quantitative counts. The species in this list were chosen because they have been shown to be common components of the reef habitats of the central and southern Pacific, and they are species that are generally visible (i.e.; non-cryptic) and easily enumerated during the course of a single 50-60 minute SCUBA survey. The list is of target organisms are as follows:

Phylum Porifera – Sponges
Phylum Cnidaria – Anemones and Hydryzoa
Phylum Annelida – marine worms
Phylum Mollusca

- Gastopoda – snails
- Opisthobranchia – sea slugs
- Bivalvia – mussels and clams
- Cephalopoda – only unidentifiable octopus and squid

Phylum Arthropoda

- Crustacea – barnacles, decapods, pericarids

Phylum Echinodermata

- Asteroidea – starfish
- Holothuroidea – sea cucumbers
- Echinoidea – sea urchins
- Ophuiroidea – brittle stars
- Crinoidea – feather stars

Phylum Bryozoa – moss animals
Phylum Chordata

- Urochordata – sea squirts

Also at this point, a variety of specialized collections will be taken:

1) Additional collections of organisms unable to be identified *in situ*
2) Sand/Sediment samples for infaunal organisms
3) Rubble, dead coral, and algal collections for symbiotic organisms or substrate-specific inhabitants

Species that cannot be identified *in situ* will be collected and brought back to the research vessel for further analysis. Organisms that are identified back at the research vessel will be returned to the field the same or next day, and species that could not be identified will be saved for further analysis at Bishop Museum in Honolulu, Hawaii. No more than two specimens are required. The specialized collections mentioned above will be sorted on board the research vessel and preserved for later identification.

Specimens saved for identification will be preserved in ways suitable for each taxonomic group. Porifera, molluscs, crustaceans, and echinoderms are to be preserved in 75% Ethanol or frozen, and soft-bodied organisms (cnidaria, sea slugs, and urochordates) will be preserved in 10% Formalin.

3. Analysis: The analysis back on Oahu will take place at Bishop Museum and will involve the use of taxonomic literature to make tentative identifications and then specimens will be sent to experts throughout the world for confirmation of these identifications. This loan process will be monitored by the Bishop Museum registrar and Invertebrate Zoology collections manager until the specimens are returned. The specimens will be permanently housed within the Bishop Museum Invertebrate Zoology collection at the end of the process. These findings and the field identifications will be given to the appropriate agency representatives sponsoring the expedition to the Hawaiian Islands National Wildlife Refuge (NWR) in the form of a final report and species list. This is a lengthy process (1-2 years), and is dependent on funding and resources for this post-expedition processing

C. Interpretation: Ultimately, field-collected specimens will be critically analyzed through the process described above, which supports efforts at documenting biodiversity associated with these remote habitats. Subsequently specimens will be made available researchers throughout the world through access to catalogued collections.

D. FWS staff and space needs: There will not be any need for FWS staff or space associated with FWS field stations

E. Hazmats: Both Ethanol and Formalin will be used as preservatives for specimens collected in the field. These will reside in chemical storage lockers on board the NOAA research vessel during operations at all locations listed in section B.

7. **Personnel:** The principal field and lab investigators include Scott Godwin, Holly Bolick, Ranya Henson and Ken Longenecker from Bishop Museum and Amy Hall and Molly Timmers from NOAA-PIFSC, Coral Reef Ecosystem Division.

8. **Costs:** No costs will be incurred by U.S. Fish and Wildlife Service in order to conduct this survey.

9. **Schedule:** The cruise will depart August, 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

10. **Transportation:** The NOAA Ship Hi'ialakai will provide transportation to and from the National Wildlife Refuge System locations.

11. **Reports:** A report of all activities carried out under the permit authority will be submitted in a timely fashion after the conclusion of the cruise. The report will include the dates of all arrivals and departures from islands and atolls within the Refuge, names of all persons involved, and results of work to date.

12. **Publications:** Publications to date under past permits:

Castro, P. and L.S, Godwin. 2005. The first records in the Hawaiian Archipelago for two genus of crab from the family Trapeziidae. Bishop Museum Occasional Papers (In press)

Asakura, A. and L.S. Godwin. 2005. A new species of hermit crab (Crustacea, Decapoda, Anomura, Diogenidae) of the genus Dardanus from the U.S Equatorial Islands. Zootaxa. (In prep).

Asakura, A. and L.S. Godwin. 2005. Diogenes maclaughlinae , a new species of hermit crab (Crustacea, Decapoda, Anomura, Diogenidae) from American Samoa. Invertebrate Taxonomy (In prep).

Godwin, L.S. 2003. Coral Reef Ecosystem Division Cruise OES-03-06, Northwestern Hawaiian Islands, Marine Invertebrates, Cruise report to NOAA, NMFS, Coral Reef Ecosystem Division

Godwin, L.S. 2002. Coral Reef Ecosystem Investigation Cruise TC-02-07, Northwestern Hawaiian Islands, Marine Invertebrates, Cruise report to NOAA, NMFS, Coral Reef Ecosystem Investigation.

Godwin, L.S. 2002. Rapid ecological assessment of the marine invertebrate fauna of American Samoa and the U.S. Phoenix and Line Islands. Preliminary report Submitted to the NOAA National Marine Fisheries Service, Honolulu Laboratory, Coral Reef Ecosystem Investigation

DeFelice, R., D. Minton and L.S. Godwin. 2002. Records of the shallow-water marine invertebrates from French Frigate Shoals, Northwestern Hawaiian Islands, with a note on non-indigenous species.

Russell E. Brainard ______________________ Date: 17 May 2006

Submitted by:

______________________ Date:______

Wildlife Biologist (Concurrence)

______________________ Date:______

Refuge Manager (Approval/Concurrence)

The following , if required:

____ Date:__________
Refuge Complex Manager (Approval/Concurrence)

____ Date:__________
Project Leader (Approval/Concurrence)

____ Date:__________
Regional Office (Approval/Concurrence)

U.S. FISH AND WILDLIFE SERVICE
Research/Management Study Proposal
Hawaiian Islands National Wildlife Refuge

1. **Name and Address of the Applicant:**

Rusty Brainard
Chief, Coral Reef Ecosystem Division
Pacific Islands Fisheries Science Center
1125-B Ala Moana Blvd
Honolulu, HI 96814

2. **Title:** Collection of macroalgae for assessment and monitoring purposes at reefs within the Hawaiian Islands National Wildlife Refuge.

3. **Background:**
Marine macroalgae are among the most poorly understood organisms in tropical reef ecosystems, yet without them coral reefs could not exist. Their importance to the ecosystem is staggering: algae form the base of the food chain, occupy much of the available benthic substrate, and help to oxygenate the water for animal life to thrive.

At this time, comprehensive species lists of algae are just beginning to be known for the majority of islands located in the Pacific Remote Islands National Wildlife Refuge complex, and every research expedition greatly adds to our knowledge of algal diversity. Additionally, CRED is beginning studies to determine relative algal abundance at these islands, and whether it changes over time. In order for baseline information of algal diversity and abundance to be determined, collections of specimens from the field are mandatory. Essentially all macroalgae need microscopic laboratory analysis for proper species identification, and voucher specimens for both qualitative and quantitative studies are necessary for research to be accepted by peer reviewed journals.

Permanent Transects: A number of permanent transects have been established at fixed sites during previous cruises, with the intention of providing georeferenced markers by which researchers can return to precise locations on subsequent cruises so as to re-survey the reef at known time intervals. Additional permanent transects may be established in 2006, and any markers that have become dislodged since their installation must be replaced/repaired. Previously-established as well as newly-established permanent transects will be surveyed in 2006.

4. Objectives:
1. Determine which macroalgal species are present in each island ecosystem and in what quantity.
2. Examine how algal diversity and abundance change over time.
3. Assess whether changes in algal populations serve as good environmental indicators of reef health.
4. Formulate biogeographical hypotheses about algal dispersal and evolution using qualitative and quantitative data from island groups around the Pacific.

5. Justification:
Worldwide concern over the degradation of coral reef ecosystems is prompting researchers to find ways to effectively monitor reef health over time. Because macroalgae are among the fastest growing organisms in tropical reef systems, they may serve as useful "early warning" indicators of environmental change. Baseline quantitative data collected from photoquadrat (picture) analysis and sample collections will provide permanent historical records that will form the foundation for long-term monitoring efforts necessary for the conservation and management of reef resources. Such monitoring will allow natural fluctuations of species abundance to be monitored and compared to areas adversely affected by anthropogenic activities or climate changes. Additionally, baseline historical studies will give researchers understanding of possible future alien species introductions, and might be critical in our ability to ameliorate any environmental damage.

Numerous species of algae unknown to science are frequently being described from Pacific Islands. Few algal experts have visited islands within the Hawaiian Islands National Wildlife Refuge, and the possibility of describing new species (thus increasing our understanding of biodiversity) is great. Detailed microscopic analysis and the placement of holotype specimens in internationally accepted herbaria are a necessary part of this process. An understanding of algal species ranges and genetic similarity across Pacific Islands will enable biogeographic hypotheses to be formulated and provide information for marine dispersal mechanism useful to biologists in many different disciplines.

Permanent Transects: Scientists were largely engaged in assessment activities on the reefs of the Hawaiian Islands National Wildlife Refuge (NWR) during 2000, 2001, and 2002, and switched to monitoring activities in 2003. Monitoring relies in large part on choosing fixed sites and resurveying them using standardized protocols during subsequent surveys. Permanent transects along with non-permanent transects within fixed sites are complementary monitoring tools. Monitoring of fish and wildlife is also an established management responsibility within all NWRs.

6. Procedures:
A. Permits: No permits other than that which is presently being sought are necessary to conduct the proposed activities.

B. Methods:
1. Study Area: Studies will occur at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Lisianski Island/Neva Shoals and Necker Island.
2. Techniques:
The goal of algal surveys is to quantitatively describe the algal community and prepare a comprehensive species list for each site. Working at depths of 3 to 16 m with teams using other existing rapid assessment methods, a method for algal assessment has been created

that minimizes the time in the water yet yields the greatest amount of data possible. A high-resolution digital camera mounted on a 0.18 m^2 photo quadrat frame with an Ikelite Substrobe digital slave strobe has been built to quantitatively assess marine algae.

In addition to photographs, data from each quadrat are recorded on a waterproof data sheet that includes space for recording the species found in the quadrat, a "map" area for identifying cryptic species in depressions that may prove difficult in computer analysis, and codes for the most common genera and species of macroalgae, corals, invertebrates, and substrate types to standardize and shorten note taking.

Two trained observers move along the transect together with one observer placing the framer and operating the camera and the other taking notes. Photographs are taken at predetermined random points. After a photograph is taken by the first diver, the second diver identifies algae within the photoquadrat, records the relative abundance of the 5 most abundant algae on a scale of 1 – 5 (with 1 being most abundant), draws a quadrat map locating species that may be hard to identify in a photograph, and collects representative samples of the algal species in the quadrats for later identification in the laboratory. Once data are recorded, the photoquadrat is moved to the next random point and the procedure repeated. To prevent redundancy and minimize impact to the environment, only samples of new algal species found in subsequent quadrats are collected. A random swim at the end of the dive is used to collect specimens not present within photoquadrats.

Permanent Transects: Establishing a permanent transect involves manual installation of hardened stainless steel stakes (12 stakes/50m transect) on hard dead substrate, away from living corals. An underwater epoxy applicator is then used to better affix the stake to the substrate. Each stake measures 3/8th – inch diameter; similar stakes have been used successfully with no signs of corrosion over a 2-year period. All other equipment (hammers, epoxy applicators, transect tapes) will be removed from the reef at the completion of each survey.

3. Analysis:

In the laboratory the photographs taken with the photoquadrat methods are downloaded to a computer, renamed with a unique location code, then cropped and color corrected in Adobe Photoshop using autocorrect. Each photo is analyzed for percent cover using the software PhotoGrid (C. Bird, Dept. of Botany, University of Hawaii), a software program capable of random and stratified random point analysis on digital photography. Once all photos are analyzed, data are imported into Microsoft Excel for further statistical application.

C. Interpretation:

Ultimately, field-collected specimens will be critically analyzed in the laboratory to ensure positive species identification, will be cataloged, and will subsequently be placed in research institutions where they can be accessed by researchers interested in a suite of topics. After identification, provisions need to made to ensure appropriate preservation and curation of each specimen, providing an historical record that will be available to future researchers.

Permanent Transects: Comparison of data over time enables the detection of change; use of additional biotic and environmental data allows inferences regarding probable drivers of change to be made.

7. Personnel: The Principal Investigator for the proposed study on algal diversity and abundance will be Dr. Peter Vroom, Algal Biologist for the Coral Reef Ecosystem Division (CRED) at the NOAA Pacific Islands Fisheries Science Center. Additional algal divers will include: Kimberly Page (CRED, UH Botany), Susan Cooper Alletto (CRED), Bonnie DeJoseph (CRED), and Erin Looney (UH Botany).

8. Costs: No costs will be incurred by U.S. Fish and Wildlife Service in order to conduct this survey.

9. Schedule: The cruise will depart August, 26 to September 29, 2006. The attached project instructions provide a detailed itinerary.

10. Transportation: All personnel will be transported to and from units of the Hawaiian Islands National Wildlife Refuge onboard the NOAA vessel *Hi'ialakai.*

11. Reports: A report of all activities carried out under the permit authority will be submitted in a timely fashion after the conclusion of each leg of the cruise. The reports will include the dates of all arrivals and departures from islands and atolls within the Refuge Complex, names of all persons involved, and preliminary results of field survey activities.

12. Publications: Selected results from previous surveys of algae conducted through Coral Reef Ecosystem Division in the Northwestern Hawaiian Islands as well as the Pacific Remote Islands National Wildlife Refuge Complex have been presented as conference posters, oral presentations, national-level reports, and publications in refereed journals. It is similarly anticipated that important results stemming from research conducted under the requested permit in 2006 will be professionally disseminated within the national and international scientific community. Furthermore, metadata records by which the original data can be obtained will be prepared and submitted to NOAA's Coral Reef Information System (CoRIS).

13. Relevant Publications:

Kenyon, J.C., P.S. Vroom, K.N. Page, M.J. Dunlap, C.B. Wilkinson, G.S. Aeby (in press) Community structure of hermatypic corals at French Frigate Shoals, Northwestern Hawaiian Islands: capacity for resistance and resilience to selective stressors. *Pacific Science.*

Vroom, Peter S., Kimberly N. Page (in press) Relative abundance of macroalgae (RAM) on Northwestern Hawaiian Island reefs. *Atoll Research Bulletin.*

Vroom, Peter S., Kimberly N. Page, Kimberly A. Peyton, J. Kanekoa Kukea-Shultz (in press) Spatial heterogeniety of benthic community assemblages with an emphasis on reef algae at French Frigate Shoals, Northwestern Hawaiian Islands. *Coral Reefs.*

Vroom, Peter S., Kimberly N. Page, Kimberly A. Peyton, J. Kanekoa Kukea-Shultz (2006) Marine algae of French Frigate Shoals, Northwestern Hawaiian Islands: Species list and biogeographic comparisons. *Pacific Science* 60: 81-95.

Vroom, Peter S. (2005) *Dasya atropurpurea* sp. nov. (Ceramiales, Rhodophyta), a deep water species from the Hawaiian archipelago. *Phycologia* 44: 572-580.

Kolinski, Steven P., Ronald K. Hoeke, Stephani R. Holzwarth, Peter S. Vroom (2005) Sea turtle abundance at isolated reefs of the Mariana archipelago. *Micronesica* 37: 287-296.

Brainard, Rusty, Jim Maragos, Robert Schroeder, Jean Kenyon, Peter Vroom, Scott Godwin, Ronald Hoeke, Greta Aeby, Russell Moffitt, Marc Lammers, Jamison Gove, Molly Timmers, Stephani Holzwarth, Steve Kolinski (2005) Status of the coral reef ecosystems of the U.S. Pacific Remote Island Areas. In: *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005.* [ed. Jenny E. Waddell]. NOAA Technical Memorandum NOS NCCOS II. NOAA/NCCOS Center for Coastal Monitoring and Assessments Biogeography Team, Silver Spring, MD.

Friedlander, Alan, Greta Aeby, Rusty Brainard, Athline Clark, Edward DeMartini, Scott Godwin, Jim Maragos, Jean Kenyon, Randy Kosaki, Peter Vroom (2005) Status of the coral reef ecosystems of the Northwestern Hawaiian Islands. In: *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005.* [ed. Jenny E. Waddell]. NOAA Technical Memorandum NOS NCCOS II. NOAA/NCCOS Center for Coastal Monitoring and Assessments Biogeography Team, Silver Spring, MD.

Friedlander, Alan, Greta Aeby, Russell Brainard, Eric Brown, Athline Clark, Steve Coles, Edward DeMartini, Steve Dollar, Scott Godwin, Cindy Hunter, Paul Jokiel, Jean Kenyon, Randy Kosaki, Jim Maragos, Peter Vroom, Bill Walsh, Ivor Williams, Wendy Wiltse (2004) Status of Coral Reefs in the Hawaiian archipelago. In: *Status of Coral Reefs of the World: 2004.* Volume 2 [ed. Clive Wilkinson]. Australian Institute of Marine Science, Townsville, Queensland, Australia, pp. 411-430.

Vroom, Peter S., Isabella A. Abbott (2004) *Scinaia huismanii* sp. nov. (Nemaliales, Rhodophyta): an addition to the exploration of the marine algae of the northwestern Hawaiian Islands. *Phycologia* 43: 445-454.

Preskitt, Linda B., Peter S. Vroom, Celia M. Smith (2004) A rapid ecological assessment (REA) quantitative survey method for benthic algae using photo quadrats with SCUBA. *Pacific Science* 58: 201-209.

Vroom, Peter S., Isabella A. Abbott (2004) *Acrosymphyton brainardii* sp. nov. (Gigartinales, Rhodophyta) from French Frigate Shoals, Northwestern Hawaiian Islands. *Phycologia* 43: 68-74.

Vroom, Peter S., Celia M. Smith (2003) Reproductive features of Hawaiian *Halimeda velasquezii* (Bryopsidales, Chlorophyta), and an evolutionary assessment of reproductive characters in *Halimeda*. *Cryptogamie, Algologie* 24: 355-370.

Vroom, Peter (2003) Paradise examined. *Arches, University of Puget Sound Alumni Magazine* 30 (4): 12-13.

Vroom, Peter S., Celia M. Smith (2003) Life without cells. *Biologist* 50: 222-226.

Vroom, Peter (2002) Algal studies. In: *Coral Reef Ecosystems of the Northwestern Hawaiian Islands* (eds. James Maragos and David Gulko), pp.18-19. U. S. Fish and Wildlife Service and the Hawai`i Department of Land and Natural Resources, Honolulu, Hawai`i.

____ Date:__________
Submitted by:

____ Date:__________
Wildlife Biologist (Concurrence)

____ Date:__________
Refuge Manager (Approval/Concurrence)

The following , if required:

____ Date:__________
Refuge Complex Manager (Approval/Concurrence)

____ Date:__________
Project Leader (Approval/Concurrence)

____ Date:__________
Regional Office (Approval/Concurrence)

Vita
Russell Eugene Brainard

EDUCATION:

Ph.D. (Physical Oceanography)	1994	Naval Postgraduate School
Certificate (Project Management)	1993	University of Washington
M.S. (Oceanography)	1986	Naval Postgraduate School
B.S. (Marine Science)	1981	Texas A&M University

EMPLOYMENT:

Supervisory Oceanographer
Chief, Coral Reef Ecosystem Division
Pacific Islands Fisheries Science Center
National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA)
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(808) 592-7011; (808) 592-7013 fax Rusty.Brainard@noaa.gov http://www.pifsc.noaa.gov/crd/

POSITIONS HELD:

2005-present	Co-PI CoML Census of Coral Reef Ecosystems (CReefs) Project
2005- present	Adjunct faculty, Department of Oceanography, University of Hawaii
2003-2004	Chair, Ecosystem Science Work Grp, NOAA Coral Reef Conservation Program
2002-present	Supervisory Oceanographer, Chief - Coral Reef Ecosystem Division, PIFSC – NOAA; PI – 12 multi-disciplinary projects - NOAA Coral Reef Program
2001-present	PI - Ocean Atlas Project, Pelagic Fisheries Research Program
2001-present	PI - Multi-agency NWHI Marine Debris Removal Project
2001-2004	Co-investigator - GhostNet Project, NASA funded
1998-2003	PI - Bigeye Tuna Oceanography Project, Pelagic Fisheries Research Program
1997-2002	Co-PI - Hawaiian Ocean Mixing Experiment, National Science Foundation
1998-2001	PI - Coral Reef Ecosystem Research Program, NOAA – Honolulu Laboratory
1981-2002	NOAA Commissioned Officer, Retired April 1, 2002 as Commander
1997-2001	Scientific Research Program Coordinator; Honolulu Laboratory
1994-1997	Commanding Officer, NOAA Ship *Townsend Cromwell*, Honolulu, HI
1992-1992	Master, R/V *Karluk*, Southeast Alaska
1990-1994	Physical Oceanographer, NOAA Pacific Marine Environmental Laboratory
1989-1990	Graduate Student, Naval Postgraduate School, Monterey, CA
1987-1989	Operations Officer, NOAA Ship *Townsend Cromwell*, Honolulu, HI
1984-1987	Res Oceanographer, NOAA Pacific Fisheries Environmental Grp, Monterey, CA
1982-1984	Station Chief – NOAA GMCC South Pole Observatory, Antarctica
1981-1982	Navigation Officer, NOAA Ship *Discoverer*, Seattle, WA

PROFESSIONAL SOCIETIES:

2003-present	International Society for Reef Studies
1986-present	American Geophysical Union - Life Member
1988-present	The Oceanography Society
1991-present	American Meteorological Society
1999-2003	Hawaii Academy of Science - Treasurer (1999-2001)

PRESENT RESEARCH ACTIVITIES:

1999-present	A comprehensive program to assess, monitor, map, and protect coral reef ecosystems of the U.S. Pacific Islands, Lead P.I. (12 inter-related projects).
~~2005-present~~	~~Census of Marine Life Census of Coral Reef Ecosystems, co-PI.~~
2001-2003	High Seas GhostNet, Driftnet Detection and Tracking in the North Pacific, co-PI.
2000-2004	Development of oceanographic atlases for pelagic and insular fisheries and resource management of the Pacific basin, Lead P.I..
1999-2004	The role of oceanography on aggregation and vulnerability of bigeye tuna in the Hawaii longline fishery using satellite, moored, and shipboard time series, P.I.
1999-2003	Analysis of historical shipboard acoustic Doppler current profiler measurements along the Hawaiian Ridge, Hawaiian Ocean Mixing Experiment (HOME), co-P.I.

PUBLICATIONS:

Firing, J., Brainard, R., and E. Firing (2006). Ten years of shipboard ADCP measurements along the Northwestern Hawaiian Islands [in press, *Atoll Research Bulletin, 543*].

Hoeke, R., R. Brainard, R. Moffitt, M. Merrifield and W. Skirving (2006). The role of oceanographic conditions and reef morphology in the 2002 coral bleaching event in the Northwestern Hawaiian Islands [in press, *Atoll Research Bulletin, 543*].

Keenan, E.E., R.E. Brainard and L.V. Basch (2006). Distribution and abundance of the pearl oyster, *pinctada margarifera* [in press, *Atoll Research Bulletin, 543*].

Kenyon, J.C., G.S. Aeby, R.E. Brainard, J.D. Chojnacki, M.J. Dunlap, and C.B. Wilkinson (2006). Mass coral bleaching on high-latitude reefs in the Hawaiian Archipelago. [in press, *Atoll Research Bulletin, 543*].

Lammers, M.O., R.E. Brainard and W.L. Au (2006). Diurnal trends in the mid-water biomass community of the Northwestern Hawaiian Islands observed acoustically. [in press, *Atoll Research Bulletin, 543*].

Brainard, R.E., M. Parke, K.B. Wong, R.Hoeke, J.M. Gove, D. Merritt, K. Hogrefe, and O. Dameron (2006). Coral reef ecosystem integrated observing system (CREIOS) in the Pacific: infrastructure for monitoring, modeling, and management. [Abstr.] Ocean Sciences Meeting, Feb. 20-24, 2006, Honolulu, HI.

Eakin, M., R. Brainard, J. Hendee, D. Hamilton, J. Lamkin, M. Monaco, K. Meckley, W. Skirving, A.E. Strong (2006). CREIOS: NOAA's Coral reef ecosystem integrated observing system. [Abstr.] Ocean Sciences Meeting, Feb. 20-24, 2006, Honolulu, HI.

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OES03-06 (NOWRAMP 2003) REA sites selected and surveyed for long-term monitoring by fish and benthic teams

*Values in parentheses are taken from cruise dive log; others are from Aeby log

Suffix following R (Rapture) and OES (Oscar Elton Sette) sites indicates survey year; TC = Townsend Cromwell

Shorthand revised site #	2003 Site #	Date	Degree decimal minutes: Latitude Degrees	minutes		Longitude Degrees	minutes		Max Depth*	Degree decimal: Latitude	Longitude
Necker											
R6	R6-00	7/14/03	23	34.511	N	164	42.348	W	37	23.5752	-164.7058
4	OES1-03	7/14/03	23	34.437	N	164	42.228	W	40	23.5740	-164.7038
2	TC2	7/14/03	23	34.693	N	164	42.384	W	43	23.5782	-164.7064
FFS											
H6	TCH6	7/15/03	23	52.835	N	166	16.425	W	38	23.8806	-166.2738
21	TC21	7/15/03	23	50.812	N	166	19.629	W	37	23.8469	-166.3272
22	TC22b	7/15/03	23	51.933	N	166	14.381	W	(40)	23.8659	-166.2554
R46	R19-02	7/16/03	23	46.168	N	166	15.680	W	27	23.7695	-166.2613
32	TC32	7/16/03	23	48.366	N	166	13.849	W	26	23.8061	-166.2308
33	OES1-03	7/16/03	23	50.142	N	166	15.952	W	22	23.8357	-166.2659
34	OES2-03	7/17/03	23	37.682	N	166	8.122	W	30	23.6280	-166.1354
R29	R2-02	7/17/03	23	40.711	N	166	8.791	W	31	23.6785	-166.1465
12	TC12	7/17/03	23	38.278	N	166	10.779	W	37	23.6380	-166.1797
R30	R3-02	7/18/03	23	51.523	N	166	12.352	W	5	23.8587	-166.2059
23	TC23F	7/18/03	23	51.943	N	166	14.382	W	16	23.8657	-166.2397
30	TC30	7/18/03	23	50.982	N	166	17.827	W	18	23.8497	-166.2971
Gardner Pinnacles											
R3	R1-02	7/19/03	24	59.812	N	167	59.929	W	40	24.9969	-167.9988
R6	R4-02	7/19/03	25	0.028	N	168	0.068	W	60	25.0005	-168.0011
R5	R3-02	7/19/03	24	59.893	N	167	59.991	W	50	24.9982	-167.9999
Maro											
R5	R1-02	7/20/03	25	72.091	N	170	30.102	W	30	25.3682	-170.5017
R6	R2-02	7/20/03	25	20.471	N	170	30.032	W	37	25.3412	-170.5005
R8	R4-02	7/20/03	25	20.053	N	170	31.514	W	36	25.3342	-170.5252
R12	R8-02	7/21/03	25	28.267	N	170	38.593	W	(60)	25.4711	-170.6432

R9	R5-02	7/21/03	25	27.681	N	170	40.982	W	(64)	25.4614	-170.6830
R3	R3-00	7/21/03	25	25.129	N	170	40.161	W	(54)	25.4188	-170.6694
8	TC8	7/22/03	25	25.023	N	170	35.036	W	(30)	25.4171	-170.5839
6	TC6	7/22/03	25	23.892	N	170	34.439	W	(50)	25.3982	-170.5740
22	TC22	7/22/03	25	22.714	N	170	34.048	W	(51)	25.3786	-170.5675
Laysan											
5	TC5	7/23/03	25	47.240	N	171	43.760	W	27	25.7873	-171.7293
R12	R6-02	7/23/03	25	46.657	N	171	44.833	W	30	25.7776	-171.7472
R9	R3-02	7/23/03	25	45.233	N	171	44.468	W	25	25.7539	-171.7411
Lisianski											
10	TC10	7/24/03	25	56.460	N	173	55.338	W	29	25.9410	-173.9223
R10	R10-02	7/24/03	25	56.675	N	173	57.212	W	35	25.9446	-173.9535
R7	R7-02	7/24/03	25	57.227	N	173	58.234	W	35	25.9538	-173.9706
R16	R16-02	7/25/03	26	0.214	N	173	59.606	W	43	26.0036	-173.9934
16	OES1-03	7/25/03	25	59.226	N	173	59.688	W	36	25.9871	-173.9948
17	OES2-03	7/25/03	25	58.155	N	173	57.774	W	30	25.9693	-173.9629
R14	R14-02	7/26/03	26	4.692	N	173	59.822	W	41	26.0782	-173.9970
12	TC12	7/26/03	26	3.957	N	174	0.099	W	24	26.0660	-174.0017
R9	R9-02	7/26/03	26	2.368	N	174	0.746	W	22	26.0395	-174.0124
Pearl & Hermes											
R39	R15-02	7/29/03	27	56.437	N	175	51.704	W	35	27.9406	-175.8617
26	TC26	7/29/03	27	57.474	N	175	48.132	W	51	27.9579	-175.8022
24	TC24	7/29/03	27	55.175	N	175	51.695	W	30	27.9196	-175.8616
R44	R20-02	7/30/03	27	54.637	N	175	54.290	W	45	27.9106	-175.9048
R22	R22-00	7/30/03	27	53.952	N	175	54.897	W	8	27.8992	-175.9150
23	TC23	7/30/03	27	52.868	N	175	55.967	W	15	27.8811	-175.9328
R26	R2-02	7/31/03	27	47.154	N	175	46.819	W	33	27.7859	-175.7803
R31	R7-02	7/31/03	27	49.605	N	175	47.518	W	30	27.8268	-175.7920
R32	R8-02	7/31/03	27	50.350	N	175	45.182	W	10	27.8392	-175.7530
33	OES1-03	8/1/03	27	47.138	N	175	49.393	W	32	27.7856	-175.8232
22	TC22	8/1/03	27	47.723	N	175	51.990	W	6	27.7954	-175.8665
30	TC30b	8/1/03	27	46.761	N	175	53.710	W	8	27.7794	-175.8952
R42	R18-02	8/2/03	27	45.185	N	175	56.941	W	46	27.7531	-175.9490
31	TC31	8/2/03	27	46.533	N	175	58.420	W	15	27.7756	-175.9737

32	TC32	8/2/03	27	46.383	N	175	56.374	W	13	27.7731	-175.9396
Midway											
2	TC2	7/28/03	28	11.843	N	177	20.765	W	35	28.1974	-177.3461
H10	TCH10	7/28/03	28	12.908	N	177	25.504	W	33	28.2151	-177.4251
R7	R5-02	7/28/03	28	11.791	N	177	22.495	W	35	28.1965	-177.3749
3	TC3b	8/6/03	28	13.077	N	177	20.631	W	23	28.2180	-177.3439
R15	R13-02	8/6/03	28	14.223	N	177	23.687	W	7	28.2371	-177.3948
H11	TCH11	8/6/03	28	13.065	N	177	24.196	W	10	28.2178	-177.4033
R3	R1-02	8/7/03	28	11.420	N	177	23.972	W	44	28.1903	-177.3995
R20	R18-02	8/7/03	28	13.914	N	177	19.077	W	5	28.2319	-177.3180
R25	R22-02	8/7/03	28	11.613	N	177	24.102	W	5	28.1936	-177.4017
H21	TCH21	8/8/03	28	16.654	N	177	21.963	W	5	28.2776	-177.3661
1	TC1	8/8/03	28	16.155	N	177	23.168	W	5	28.2693	-177.3861
Kure											
12	TC12	8/3/03	28	22.951	N	178	19.484	W	34	28.3826	-178.3253
R33	R7-02	8/3/03	28	25.006	N	178	22.706	W	49	28.4163	-178.3778
17	TC17	8/3/03	28	25.929	N	178	21.974	W	4	28.4316	-178.3659
2	TC2	8/4/03	28	27.218	N	178	20.626	W	32	28.4535	-178.3432
18	TC18	8/4/03	28	25.087	N	178	20.649	W	18	28.4180	-178.3444
9	TC9	8/4/03	28	24.346	N	178	20.537	W	11	28.4058	-178.3423
R36	R10-02	8/4/03	28	25.215	N	178	22.281	W	7	28.4206	-178.3715
14	TC14	8/5/03	28	27.229	N	178	19.684	W	5	28.4536	-178.3282
R35	R9-02	8/5/03	28	23.581	N	178	20.958	W	7	28.3925	-178.3495

Location	PlatformType	Latitude	Longitude	Depth (m)	Deployment Date
NWHI: Necker	ODP	23.57	-164.71	24.9	4/10/2005
NWHI: Necker	STR	23.57	-164.70	17.07	4/10/2005
NWHI: French Frigate Shoals	STR	23.77	-166.26	3.96	9/17/2004
NWHI: French Frigate Shoals	STR	23.74	-166.17	2.01	9/17/2004
NWHI: French Frigate Shoals	STR	23.62	-166.12	1.83	9/18/2004
NWHI: French Frigate Shoals	STR	23.86	-166.27	7.9	9/18/2004
NWHI: French Frigate Shoals	STR	23.87	-166.22	2.1	9/19/2004
NWHI: French Frigate Shoals	STR	23.86	-166.27	1	4/11/2005
NWHI: French Frigate Shoals	CREWS-ENH	23.86	-166.27	7.32	4/11/2005
NWHI: Gardner	STR	25.00	-168.00	10.36	9/20/2004
NWHI: Maro	STR	25.45	-170.63	8.53	12/23/2004
NWHI: Maro	STR	25.38	-170.54	1.83	9/21/2004
NWHI: Maro	STR	25.37	-170.51	4.27	9/21/2004
NWHI: Maro	CREWS-STD	25.45	-170.63	8.83	10/16/2005
NWHI: Laysan	SST-ARGOS	25.77	-171.74	3.3	9/24/2004
NWHI: Laysan	STR	25.78	-171.74	1.21	9/24/2004
NWHI: Laysan	STR	25.76	-171.73	0.91	9/24/2004
NWHI: Laysan	STR	25.77	-171.74	3.3	6/13/2005
NWHI: Lisianski	WTR	26.10	-174.00	23.46	10/9/2004
NWHI: Lisianski	WTR	25.94	-173.88	14.9	10/10/2004
NWHI: Lisianski	STR	26.06	-173.96	0.61	10/9/2004
NWHI: Lisianski	STR	25.97	-173.92	8.53	10/10/2004
NWHI: Lisianski	SST-ARGOS	25.97	-173.92	10.7	6/14/2005
NWHI: Pearl and Hermes	CREWS-STD	27.85	-175.82	7.9	9/27/2004
NWHI: Pearl and Hermes	STR	27.96	-175.78	0.61	9/27/2004
NWHI: Pearl and Hermes	STR	27.85	-175.82	7.9	9/27/2004
NWHI: Pearl and Hermes	STR	27.90	-175.83	1.83	9/28/2004
NWHI: Pearl and Hermes	STR	27.80	-175.78	1.5	9/28/2004
NWHI: Pearl and Hermes	STR	27.78	-175.88	23.16	9/29/2004
NWHI: Pearl and Hermes	STR	27.91	-175.89	2.4	10/1/2004
NWHI: Midway	ODP	28.23	-177.43	29.26	10/4/2004
NWHI: Midway	STR	28.24	-177.32	0.91	10/2/2004
NWHI: Midway	STR	28.28	-177.37	0.91	10/2/2004
NWHI: Midway	STR	28.27	-177.39	1.52	10/2/2004
NWHI: Midway	STR	28.19	-177.40	0.91	10/2/2004
NWHI: Midway	STR	28.22	-177.34	9.14	7/1/2005
NWHI: Kure	SST-ARGOS	28.42	-178.34	9.8	6/29/2004
NWHI: Kure	CREWS-STD	28.42	-178.34	9.7	10/5/2004
NWHI: Kure	WTR	28.39	-178.28	14.9	10/6/2004
NWHI: Kure	WTR	28.45	-178.36	27.1	10/7/2004
NWHI: Kure	STR	28.42	-178.34	9.75	10/5/2004
NWHI: Kure	STR	28.43	-178.37	0.61	10/7/2004
NWHI: Kure	STR	28.45	-178.31	0.61	10/8/2004

FAX

Northwestern Hawaiian Islands Marine National Monument

To: Athline/Bill **From:** Moani

Fax: 587-0115 **Pages:** 4

Phone: **Date:** 7/13/06

Re: Monument Recommendations - VROOM Permit

☐ **Urgent** ☒ **For Review** ☐ **Please Comment** ☐ **Please Reply** **Please Recycle**

Athline -

Call me if you need to.

Thank you

Moani

6600 Kalaniana'ole Hwy., #300 Honolulu, Hawai'i 96825 Phone: 808-397-2660 Fax: 808-397-2662
Website: http://hawaiireef.noaa.gov

ATTACHMENT 1

Northwestern Hawaiian Islands Marine National Monument
NOAA/NOS/NMSP
Comments on State of Hawaii NWHI Marine Refuge Permits

PERMIT SUMMARY

Title: NWHI Reef Assessment and Monitoring Program (RAMP)
Project Leader: Russell Brainard
Location: Necker Island, French Frigate Shoals, Laysan, Maro, Gardner Pinnacles, Lisianski Island, Neva Shoal, Pearl and Hermes Atoll, Kure Atoll, State Wildlife Refuge
Description: 2006 NWHI Reef Assessment and Monitoring Program (RAMP)

BACKGROUND

This monitoring cruise began in 2000 and has received permits from the Reserve since 2004. This is an annual monitoring cruise that is conducted jointly by CRED and the now Monument.

MANAGEMENT RELEVANCE TO THE MONUMENT

Continuation of this ongoing annual time series is an important component of the Monument's coral reef monitoring program, it could potentially give us a better understanding of the range of variability within a coral reef ecosystem that is relatively free of anthropogenic impacts.

POTENTIAL IMPACTS

Most of the activities proposed under this permit application pose minimal impact on natural resources. However, the monitoring of bottomfish population work proposed as part of this application raises concerns about impact to the environment:

- The impact of dropping cement anchors weighing approximately 300 pounds to the ocean floor may cause significant damage.
- It is unknown if dropping these anchors will cause changes in bottomfish behaviors.

MONUMENT RECOMMENDATION

The Monument supports the research mission and activities outlined in the permit application and recommends issuing the permit as requested with the exception of the monitoring of bottomfish populations with camera bait stations. However, additional clarification is requested (see below).

Need further clarification on:
Our assumption is that no more than one marine algae voucher specimen per species will be collected at each monitoring site. For the marine algae collections, need clarification on number of samples and sample sizes.

Regarding the coral samples to be collected at each island/reef system visited, clarification is needed to determine whether the proposed research is duplicative of that which occurred on the May cruise.

Installing permanent transect pins is a significant deviation from previous REA protocols. Were all taxonomic groups and jurisdictional partners (who were involved in development of these methods) consulted with?

Specific Recommendations:

- The applicant states that no live organisms will be kept alive after collections. Precautions must be put in place to ensure that nothing is brought back alive.
- The proposed BOTCAM activity is in a research and development phase and should not occur until such time that a clear monitoring objective is identified or a hypothesis is clearly stated that can be effectively tested by this method. Furthermore, until these issues have been clarified, testing this methodology could be conducted in the main Hawaiian Islands.
- Applicants should be provided with a briefing on the Native Hawaiian cultural significance of the area.
- Discharge must be regulated in accordance with Monument prohibitions when transiting Monument waters.

Conditions:

X Partial Approval O Approve with conditions

O Disapprove

Monument staff Reviewers:

X Malia Chow, Ph.D.
X Randy Kosaki, Ph.D.
X Moani Pai
X Kekuewa Kikiloi
X Hoku Johnson
X Kaylene Keller
X Sean Corson

Manager's concurrence with staff recommendation

'Aulani Wilhelm, Acting Reserve Manager

Response by Applicant to Review Questions

August 2, 2006

Compiled comments on Brainard/Vroom NWHI-RAMP Permit application:

IN GENERAL: a complete proposed-collection table is necessary – what species, or at least genera or families, would you like to collect?

Coral – Please add *Porites lobata, Acropora valida, Pocillopora damicornis,* and *Pocillopora ligulata* to the original list of coral species provided in the permit, and remove *Montipora incrassata* and *Montipora dilatata.*
.Algae - See Appendix A for Algal genera documented in past years.
Invertebrates - We do not have this information at this point in time, but are in the process of collecting more information and will provide it when available.
Fish – No fish will be collected as part of REA or towed diver surveys.

Methods aren't very specific, mostly say "we'll collect anything we can't identify". What sorts of sample numbers has this resulted in with past collections?

See response under "ALGAE" below.

ALGAE
Re: algal collections: more information would be helpful. What species are you likely to encounter? What species have you already collected? Will these collections be duplicative? How many samples of how many types of algae do you propose to collect?

Over 800 species of marine algae are known from the Northwestern Hawaiian Islands, any of which we are likely to encounter. Two books (Abbott 1999; Abbott & Huisman 2004) form the species list of what may be collected. Additionally, a species list of algae from French Frigate Shoals was recently published (Vroom et al. 2006). An Excel table of CRED records of macroalgae from the NWHI is also being provided. As has been standard protocol since 2001, we attempt to collect one sample of each species per site. Most of these samples are microscopic species of turf algae and epiphytes. We do end up with thousands of samples that need to be processed and described once we return to shore, but most of these samples are microscopic species of turf algae and epiphytes. Because microscopy is necessary to confirm identities of essentially all algal species (including large macroalgae), no species level qualitative or quantitative studies of algal populations can be made without collecting samples. An algal sample is one plant. Most tropical Pacific algae range in size from 1 millimeter to several centimeters in height. Our past research at French Frigate Shoals has found over 50% of algal diversity in the NWHI to consist of filamentous algae that are less than 1 centimeter tall, and commonly grow on larger forms of macoalgae as epiphytes. These algae only become obvious under a dissecting microscope and because of their minute size, are not consciously collected in the field, but are collected incidentally on other plants. A typical site in the NWHI

ATTACHMENT 2

would contain thousands to millions of individuals of each algal species, and removing one representative of each individual macroalga, or a small section (1 cm2) of the turf community per site, would have no to minimal impact on the reef system. Algal samples are kept in the Pacific Island Fisheries Science Center's Coral Reef Ecosystem Division's herbarium until publication of results. After publication, specimens are transferred to the Bishop Museum. The Bishop Museum then arranges for replicate samples to be transferred to other international herbaria (e.g. the Smithsonian Institution).

Because of a change of personnel, no endolithic algal research will be conducted in the NWHI at this time and sections of the permits pertaining to endolithic algae can be disregarded. A modified version of the algal permit is attached.

Abbott, I. A. (1999) Marine Red Algae of the Hawaiian Islands. Bishop Musuem Press, 465 pp.

Abbott, I. A., J. M. Huisman (2004) Marine Green and Brown Algae of the Hawaiian Islands. Bishop Museum Press, 259 pp.

Vroom, P. S., K. N. Page, K.A. Peyton, J. K. Kukea-Shultz (2006) Marine algae of French Frigate Shoals, northwestern Hawaiian islands: Species list and biogeographic comparisons. Pacific Science 60: 81-95.

CORALS

Coral collection sample sizes should be re-tooled to take into account the collections already made in the NWHI, for example, 61 *Montipora capitata* samples have been taken and archived by Gates and Toonen from 7 sites – why not utilize these? Is this research duplicative?

The permit application has been written to request a maximum number of specimens to be collected based upon *in situ* observations of coral disease and in an attempt to better understand its etiology, in part through histological analysis. The Gates/Toonen study was oriented towards genetic analyses (i.e., molecular studies). The preservative used for molecular studies (95% ethanol) is not conducive to good preservation for histology, as it causes shrinkage and introduces other artifacts that interfere with histological interpretation. Hence the goals of the present study (coral disease) are different from those of Gates/Toonen (genetic markers); the research is not duplicative. Because the coral samples require preservation in a medium which best conserves the features that are the goals of the study, sub-samples cannot be readily shared between investigators.

Dr. Greta Aeby also made collections for the study of coral disease in 2005. If we encounter the same types of coral diseases and syndromes that Aeby has reported, then we have no need to collect. However, in the case that we encounter new syndromes, it would be very desirable to collect sample specimens in order characterize the disease. It should also be considered that:

i) The etiology for the majority of afflictions/syndromes affecting corals in the Main Hawaiian Islands and the NWHI has not yet been characterized. Multiple collections (by different researchers) allow researchers to detect the full range of gross morphological/physiological variability for a specific affliction/syndrome.

ii) Nomenclature of gross lesions is generally used as a first step toward disease characterization. The advantage of this approach is that it focuses on describing the lesion instead of providing subjective interpretation with regards to disease causality. As more data are collected (in part from multiple collection samples) sufficient information will be eventually gathered, which will likely bring about a more refined and systematic nomenclature of the gross lesions, as well as a better understanding of the disease cause-effect relationships.

iii) Different diseases may affect the same coral colony. Thus, there may be the case in which a specific coral colony exhibits two or more types of afflictions, for which a scientist already collected samples from other colonies, but not from the particular colony exhibiting multiple diseases. Sample collections would be desirable in order to study the additive/synergistic effects of disease on coral health.

iv) Corals and corals reefs are constantly exposed to multiple levels of environmental disturbances, which in moderate levels are predicted to increase community richness and diversity, hence complexity (Intermediate Disturbance Hypothesis; Connell 1978). The lesions inflicted to corals at the time of sample collection are minimal in terms of physical damage, as well as rare, in terms of the temporal frequency. Injury caused to corals due to collection is insignificant, compared to injury continuously inflicted by corallivores, grazers, and bioeroders. All coral sample collection conducted for disease characterization is conducted under guidelines that prioritize minimal damage possible to the mother colony.

The sampling table does not include *Porites lobata* – a number of samples of this species are archived at HIMB, but this species is listed as being collected in the algae protocols section. Can you use archived samples, or do you need to collect it? If you want to collect it, it should be in the species collection table.

Porites lobata should have been included in the table and will need to be added.

INVERTEBRATES

The collection table only asks for trapezid crabs and corals, but the USFWS documentation talks about collecting sponges, mollusks, crustaceans, echinoderms, cnidaria, sea slugs, etc. What exactly is to be collected, in terms of invertebrates?

We do not have this information at this point in time, but are in the process of collecting more information and will provide it when available.

EQUIPMENT INTALLATION

How many permanent transects will be installed, and where? Why this departure from historical procedures?

Our transects are not a departure from historical procedures. The sites we monitor are the same sites that have been monitored by NOAA, USFWS, and State personnel since 2000, but because of a lack or time or funds, no permanent transects were ever installed at these sites. We are merely continuing the process of establishing permanent transects at these already existent monitoring locations. The methods and types of transects being installed are consistent with those already established through the USFWS.

We hope to install permanent transect markers at 49 of the 73 long-term monitoring sites. Permanent transect markers, which were installed in previous years by Dr. Jim Maragos (U.S. Fish and Wildlife Service) and Dr. Greta Aeby (HIMB) already exist at or close enough to the remaining 24 sites (i.e., within 100m) chosen for long-term monitoring by CRED in 2003 that we will be "synonymizing" those sites (i.e. shifting, as necessary, our long-term monitoring GPS coordinates slightly so as to use these permanent transects). The Table below shows the location of sites, which distinguishes those where permanent transect markers already exist from those where CRED hopes to install such markers. (Please note that 4 sites are listed at Laysan, as site R11 had to be substituted in 2004 for site 5, which was too rough to be surveyed that year.)

The purpose of establishing permanent transect markers along which transect lines can be deployed is to reduce error due to spatial imprecision in transect line deployment between sample years, and thus improve the accuracy of data by which temporal change is assessed.

Appendix I. CRED long-term monitoring sites
Sites where permanent transects presently exist are highlighted in gray

	Latitude (N)		Longitude (W)	
Site #	Degrees	minutes	Degrees	minutes
Necker				
R6	23	34.524	164	42.312
4	23	34.437	164	42.228
2	23	34.693	164	42.384
FFS				
H6	23	52.812	166	16.392
21	23	50.822	166	19.630
22	23	51.933	166	14.381

R46	23	46.158	166	15.696
32	23	48.366	166	13.849
33	23	50.142	166	15.952
34	23	37.682	166	8.122
R29	23	40.711	166	8.791
12	23	38.323	166	10.802
R30	23	51.994	166	12.870
23	23	51.943	166	14.382
30	23	50.993	166	17.846
Gardner Pinnacles				
R3	24	59.812	167	59.929
R6	25	0.028	168	0.068
R5	24	59.934	167	59.988
Maro				
R5	25	22.091	170	30.102
R6	25	20.471	170	30.032
R8	25	20.053	170	31.514
R12	25	28.279	170	38.574
R9	25	27.671	170	40.994
R3	25	25.129	170	40.161
8	25	25.000	170	35.030
6	25	23.892	170	34.439
22	25	22.720	170	34.044
Laysan				
5	25	47.240	171	43.760
R12	25	46.657	171	44.833
R9	25	45.233	171	44.468
R11	25	45.932	171	44.653
Lisianski				
10	25	56.460	173	55.338
R10	25	56.675	173	57.212
R7	25	57.227	173	58.234
16	25	59.226	173	59.688
17	25	58.155	173	57.774
R14	26	4.692	173	59.822
12	26	3.957	174	0.099
R9	26	2.368	174	0.746
18	26	0.253	173	59.659
Pearl & Hermes				
R39	27	56.437	175	51.704
26	27	57.468	175	48.125
24	27	55.175	175	51.695
R44	27	54.631	175	54.280
R22	27	53.952	175	54.897
23	27	52.868	175	55.967

R26	27	47.154	175	46.819
R31	27	49.605	175	47.518
R32	27	50.072	175	45.210
33	27	47.138	175	49.393
22	27	47.723	175	51.990
30	27	46.761	175	53.710
R42	27	45.185	175	56.941
31	27	46.532	175	58.401
32	27	46.351	175	56.370
Midway				
2	28	11.843	177	20.765
H10	28	12.908	177	25.504
R7	28	11.791	177	22.495
3	28	13.068	177	20.639
R15	28	14.223	177	23.687
H11	28	13.065	177	24.196
R3	28	11.420	177	23.972
R20	28	13.902	177	19.086
R25	28	11.616	177	24.102
H21	28	16.650	177	21.978
1	28	16.148	177	23.181
Kure				
12	28	22.951	178	19.484
R33	28	25.006	178	22.706
17	28	25.912	178	22.003
2	28	27.218	178	20.626
18	28	25.087	178	20.649
9	28	24.346	178	20.537
R36	28	25.215	178	22.281
14	28	27.209	178	19.716
R35	28	23.581	178	20.958

BOTCAM

How many blocks of concrete will be left behind by BOTCAM? How will this affect bottomfish behavior? There is concern that dropping these cement anchors might cause significant damage to the seafloor. Consensus is that BOTCAM methods should be better researched and developed in a less sensitive environment than the NWHI (perhaps testing in the main Hawaiian Islands could prove feasibility of the methodology).

Botcam is no longer slated to occur on the cruise. The Botcam permits can be disregarded.

Algal Genera Collected on Past Cruises

Common name	Scientific Name	Family	Order	Class	Division	Kingdom
Algae	Caulerpa	Caulerpaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Caulerpella	Caulerpaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Codium	Codiaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Halimeda	Halimedaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Bryopsis	Bryopsidaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Derbesia	Bryopsidaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Pseudobryopsis	Bryopsidaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Avrainvillea	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Chlorodesmis	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Rhipidosiphon	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Rhipilia	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Tydemania	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Udotea	Udoteaceae	Bryopsidales	Ulvophyceae	Chlorophyta	Plantae
Algae	Palmophyllum		Chlorococcales	Ulvophyceae	Chlorophyta	Plantae
Algae	Phyllodictyon	Anadyomenaceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Cheatomorpha	Cladophoraceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Cladophora	Cladophoraceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Dictyosphaeria	Siphonocladaceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Microdictyon	Anadyomenaceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Valonia	Valoniaceae	Cladophorales	Ulvophyceae	Chlorophyta	Plantae
Algae	Acetabularia	Polyphysaceae	Dasycladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Bornetella	Dasycladaceae	Dasycladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Neomeris	Dasycladaceae	Dasycladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Boodlea	Boodleaceae	Siphonocladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Siphonocladus	Siphonocladaceae	Siphonocladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Ventricaria	Siphonocladaceae	Siphonocladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Entocladia	Ulvellaceae	Ctenocladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Ulvella	Ulvellaceae	Ctenocladales	Ulvophyceae	Chlorophyta	Plantae
Algae	Ulothrix	Ulotrichaceae	Ulotrichales	Ulvophyceae	Chlorophyta	Plantae
Algae	Uronema	Ulotrichaceae	Ulotrichales	Ulvophyceae	Chlorophyta	Plantae
Algae	Ulva	Ulvacaeae	Ulvales	Ulvophyceae	Chlorophyta	Plantae

Algae	Chnoospora	Dictyosiphonaceae	Dictyosiphonales	Phaeophyceae	Phaeophyta	Protista
Algae	Dictyota	Dictyotaceae	Dictyotales	Phaeophyceae	Phaeophyta	Protista
Algae	Distromium	Dictyotaceae	Dictyotales	Phaeophyceae	Phaeophyta	Protista
Algae	Lobophora	Dictyotaceae	Dictyotales	Phaeophyceae	Phaeophyta	Protista
Algae	Padina	Dictyotaceae	Dictyotales	Phaeophyceae	Phaeophyta	Protista
Algae	Stypopodium	Dictyotaceae	Dictyotales	Phaeophyceae	Phaeophyta	Protista
Algae	Asteronema	Ectocarpaceae	Ectocarpales	Phaeophyceae	Phaeophyta	Protista
Algae	Feladmannia	Ectocarpaceae	Ectocarpales	Phaeophyceae	Phaeophyta	Protista
Algae	Hincksia	Ectocarpaceae	Ectocarpales	Phaeophyceae	Phaeophyta	Protista
Algae	Sargassum	Sargassaceae	Fucales	Phaeophyceae	Phaeophyta	Protista
Algae	Turbinaria	Sargassaceae	Fucales	Phaeophyceae	Phaeophyta	Protista
Algae	Hydroclathrus	Scytosiphonaceae	Scytosiphonales	Phaeophyceae	Phaeophyta	Protista
Algae	Sphacelaria	Sphacelariaceae	Sphacelariales	Phaeophyceae	Phaeophyta	Protista
Algae	Sporochnus	Sporochnaceae	Sporochnales	Phaeophyceae	Phaeophyta	Protista
Algae	Bangia	Bangiaceae	Bangiales	Bangiophyceae	Rhodophyta	Protista
Algae	Porphyra	Bangiaceae	Bangiales	Bangiophyceae	Rhodophyta	Protista
Algae	Asparagopsis	Bonnemaisoniaceae	Bonnemaisoniales	Florideophyceae	Rhodophyta	Protista
Algae	Aglaothamnion	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Anotrichium	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Antithamnion	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Centroceras	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Ceramium	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Corallophila	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Crouania	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Griffithisa	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Haloplegma	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Lejolisea	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Ptilothamnion	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Spryridea	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Wrangelia	Ceramiaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Dasya	Dasyaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Heterosiphonia	Dasyaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Hypoglossum	Delesseriaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Martensia	Delesseriaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Schizoseris	Delesseriaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Vanvoorstia	Delesseriaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Amansia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista

Algae	Chondria	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Chondrophycus	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Herposiphonia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Laurencia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Lophosiphonia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Neosiphonia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Polysiphonia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Spriocladia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Womersleyella	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Amansia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Algae	Tolypiocladia	Rhodomelaceae	Ceramiales	Florideophyceae	Rhodophyta	Protista
Branched coralline algae	non-geniculate	Corallinaceae	Corallinales	Florideophyceae	Rhodophyta	Protista
Crustose coralline algae		Corallinaceae	Corallinalles	Florideophyceae	Rhodophyta	Protista
Algae	Amphiroa	Corallinaceae	Corallinalles	Florideophyceae	Rhodophyta	Protista
Algae	Hydrolithon	Corallinaceae	Corallinales	Florideophyceae	Rhodophyta	Protista
Algae	Jania	Corallinaceae	Corallinales	Florideophyceae	Rhodophyta	Protista
Algae	Mastophora	Corallinaceae	Corallinales	Florideophyceae	Rhodophyta	Protista
Algae	Erythrotrichia	Erythropeltidaceae	Erythropeltidales	Florideophyceae	Rhodophyta	Protista
Algae	Gelidium	Gelidiaceae	Gelidiales	Florideophyceae	Rhodophyta	Protista
Algae	Pterocladiella	Gelidiaceae	Gelidiales	Florideophyceae	Rhodophyta	Protista
Algae	Acrosymphyton	Acrosymphytaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Caulacanthus	Caulerpaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Gibsmithia	Dumontiaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Carpopeltis	Halymeniaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Halymenia	Halymeniaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Hypnea	Hypnaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Kallymenia	Kallymeniaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Predaea	Nemastomataceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Peyssonnelia	Peyssonneliaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Ahnfeltiopsis	Phyllophoraceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Plocamium	Plocamiaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Portieria	Rhizophyllidaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Platoma	Schizymeniaceae	Gigartinales	Florideophyceae	Rhodophyta	Protista
Algae	Gracilaria	Gracilariaceae	Gracilariales	Florideophyceae	Rhodophyta	Protista
Algae	Actinotrichia	Galaxauraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Galaxaura	Galaxauraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Ganonema	Galaxauraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista

Algae	Scinaia	Galaxauraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Tricleocarpa	Galaxauraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Liagora	Liagoraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Trichogloea	Liagoraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Trichogloeopsis	Liagoraceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Yamadaella	Dermonemataceae	Nemaliales	Florideophyceae	Rhodophyta	Protista
Algae	Stylonema	Porphyridiaceae	Porphyridiales	Florideophyceae	Rhodophyta	Protista
Algae	Gelidiopsis	Lomentariaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Gloiocladia	Lomentariaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Lomentaria	Lomentariaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Botryocladia	Rhodymeniaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Chrysymenia	Rhodymeniaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Coelarthrum	Rhodymeniaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Coelothrix	Rhodymeniaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Algae	Halichrysis	Rhodymeniaceae	Rhodymeniales	Florideophyceae	Rhodophyta	Protista
Blue green algae	cyanobacteria					Monera
Turf algae						

Corals Collection Table

Corals to be collected may include:

Acropora cytherea
Acropora paniculata
Acropora valida
Montipora capitata
Porites lutea = Porites everamanni
Porites rus
Porites compressa
Pocillopora damicornis
Pocillopora eydouxi
Pocillopora ligulata
Pocillipora meandrina
Montipora turgescens
Monitopora flabellata
Montipora patula
crustose coralline algae

The following protected species will NOT be collected:

Montipora incrassata
Monitopora dilatata

Mooring Coordinates

EventDate	Location	PlatformType	Depth	Latitude	Longitude
6/29/2004	NWHI: Kure	SST-ARGOS	9.8	28-25.0897'N	178-20.5915'W
10/5/2004	NWHI: Kure	CREWS-STD	9.7	28-25.115'N	178-20.674'W
9/27/2004	NWHI: Pearl and Hermes	CREWS-STD	7.9	27-51.2381'N	175-48.9560'W
9/24/2004	NWHI: Laysan	SST-ARGOS	3.3	25-46.344'N	171-44.550'W
10/6/2004	NWHI: Kure	WTR (Wave & Tide Recorder)	14.9	28-23.446'N	178-16.978'W
10/7/2004	NWHI: Kure	WTR (Wave & Tide Recorder)	27.1	28-27.131'N	178-21.432'W
10/9/2004	NWHI: Lisianski	WTR (Wave & Tide Recorder)	23.46	26-06.008'N	173-59.880'W
10/10/2004	NWHI: Lisianski	WTR (Wave & Tide Recorder)	14.9	25-56.588'N	173-53.075'W
10/4/2004	NWHI: Midway	ODP	29.26	28-13.916'N	177-25.783'W
12/23/2004	NWHI: Maro	SBE39	8.53	25-26.786'N	170-38.029'W
9/24/2004	NWHI: Laysan	SBE39	1.21	25-46.7721'N	171-44.3338'W
9/24/2004	NWHI: Laysan	SBE39	0.91	25-45.5359'N	171-43.7648'W
9/27/2004	NWHI: Pearl and Hermes	SBE39	0.61	27-57.459'N	175-46.849'W
9/27/2004	NWHI: Pearl and Hermes	SBE39	7.9	27-51.2381'N	175-48.9560'W
9/28/2004	NWHI: Pearl and Hermes	SBE39	1.83	27-53.878'N	175-49.880'W
9/28/2004	NWHI: Pearl and Hermes	SBE39	1.5	27-48.162'N	175-46.760'W
9/29/2004	NWHI: Pearl and Hermes	SBE39	23.16	27-46.928'N	175-52.859'W
10/1/2004	NWHI: Pearl and Hermes	SBE39	2.4	27-54.711'N	175-53.659'W
10/2/2004	NWHI: Midway	SBE39	0.91	28-14.672'N	177-19.404'W
10/2/2004	NWHI: Midway	SBE39	0.91	28-16.66'N	177-22.072'W
10/2/2004	NWHI: Midway	SBE39	1.52	28-16.263'N	177-23.161'W
10/2/2004	NWHI: Midway	SBE39	0.91	28-11.615'N	177-24.107'W
10/5/2004	NWHI: Kure	SBE39	9.75	28-25.115'N	178-20.674'W
10/7/2004	NWHI: Kure	SBE39	0.61	28-25.756'N	178-22.107'W
10/8/2004	NWHI: Kure	SBE39	0.61	28-26.844'N	178-18.362'W
10/9/2004	NWHI: Lisianski	SBE39	0.61	26-3.801'N	173-57.659'W
10/10/2004	NWHI: Lisianski	SBE39	8.53	25-58.06'N	173-54.966'W
9/17/2004	NWHI: French Frigate Shoals	SBE39	3.96	23-46.138'N	166-15.679'W
9/17/2004	NWHI: French Frigate Shoals	SBE39	2.01	23-44.289'N	166-10.01'W
9/18/2004	NWHI: French Frigate Shoals	SBE39	1.83	23-37.31'N	166-07.256'W
9/18/2004	NWHI: French Frigate Shoals	SBE39	7.9	23-51.409'N	166-16.311'W
9/19/2004	NWHI: French Frigate Shoals	SBE39	2.1	23-51.957'N	166-13.194'W
9/20/2004	NWHI: Gardner	SBE39	10.36	24-59.9297'N	167-59.9748'W
9/21/2004	NWHI: Maro	SBE39	1.83	25-23.046'N	170-32.384'W
9/21/2004	NWHI: Maro	SBE39	4.27	25-22.018'N	170-30.823'W
4/11/2005	NWHI: French Frigate Shoals	SBE39	1	23-51.407'N	166-16.31'W
4/11/2005	NWHI: French Frigate Shoals	CREWS-ENH	7.32	23-51.407'N	166-16.31'W
4/10/2005	NWHI: Necker	ODP	24.9	23-34.075'N	164-42.729'W
4/10/2005	NWHI: Necker	SBE39	17.07	23-34.291'N	164-41.865'W
4/11/2005	NWHI: French Frigate Shoals	Ghostnet-ATI	8.23	23-51.377'N	166-16.506'W
6/13/2005	NWHI: Laysan	SBE39	3.3	25-46.344'N	171-44.550'W
6/14/2005	NWHI: Lisianski	SST-ARGOS	10.7	25 58.062'N	173 54.960'W

7/1/2005	NWHI: Midway	SBE39	9.14	28-13.094'N	177-20.662'W
8/3/2005	MHI: Lanai	SBE39	11.89	20-44.3173'N	156-52.4909'W
10/16/2005	NWHI: Maro	CREWS-STD	8.83	25-26.786'N	170-38.029'W